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SOUND MOTION PICTURES

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FROM THE LABORATORY TO THEIR PRESENTATION

by

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FOREWORD

The aim of this book is to present a condensed record of the progress of "sound" in motion pictures. In attempting to write the history of the new device, the author of course realizes fully that it is as yet too early to base judgment on a perspective that can come only with time and experience. Yet because an entire industry is adjusting itself overnight to a new condition, the very interest in the subject would appear to justify this text.

While there may be difference of opinion among a few observers as to the importance of sound in relation to motion pictures, it cannot be denied that practically every element in the industry has accepted sound as here to stay. Virtually all outstanding producers have built elaborate sound studio units, equipped with intricate recording devices, representing huge investments. Who can fail to see in all this an indication of the confidence that the industry has in the future of sound?

Indeed, it is felt by many authorities that this new development is but a forerunner of improvements that will come. For the first time since Edison gave us the motion picture, the laboratories of important electrical organizations have become interested in the possibilities of the screen. This sort of technical alliance must surely result in bringing about countless changes that will be of moment to those within the industry. Just as sound has stimulated public interest in the motion picture anew, it may be expected that further improvements will refresh attention and keep it flourishing.

A related aim of this book, therefore, is to analyze and clarify many problems upon which the future of the new art must be established.

Feeling as I do that a pioneer volume in a new field should serve every possible variety of demand, I have deliberately widened the scope to the utmost. Accordingly I believe that these pages will serve almost every one interested in the subject at least to some degree. It is therefore only natural that some portions of the text, introduced with a special public in mind, will be of less interest to some other reader of different need. For example, the two chapters on operation and maintenance that conclude the division on the theatre are intended solely for the professional exhibitor. Certain paragraphs, likewise, in connection with the apparatus of production and reproduction are designedly technical. I do not see how these could very well be omitted without diminishing the value of my message to the industry. Since it is my hope to render practical as well as general information, I accordingly offer scientific detail together with matter of wider appeal.

My aim is first to provide the professional worker with either a full reference or a sure guidance, depending on his period of acquaintance with sound. If he be a "veteran," here is the record for him to review; if a newcomer, here are the lessons he must learn. In employing a word from the classroom I am especially mindful of those who are already entering our ranks through the gate of university or other institutional training. Knowing that their number is growing and will continue to grow, I have attempted to provide for their ready instruction a manual suitable for survey. With that purpose in view, I have been careful to organize the chapters into groups and the whole book into an organic unit.

Naturally, a good moving picture man never loses sight of

the lay public. Readers of non-professional curiosity will therefore find much here to absorb a healthy inquisitiveness concerning this freshest miracle of science and industry. And it goes without saying that I have been at infinite pains to make every division of my text, and every last sentence, clear and self-explanatory.

The last chapter contains a discussion of the future. Much of this, naturally, expresses my own conclusions; for I offer it rather as a forerunner of many extensive discussions than as a body of definite findings. When the day comes for a retrospective book on sound, I pray that I may be at hand to say my little say. What the world needs now is a trail-blazer, and I know that my readers will understand this. On the other hand, I have spared no effort at fullness or accuracy according to the strictest standards that obtain. Should the book, therefore, provide some of my fellows with a good start in the right direction, I shall not feel my modest labours misplaced or wasted!

The industry owes a debt of gratitude to William Fox and Warner Brothers for the pioneering they have done in their experiments with the application of sound. Because of their faith and vision, they have added a second chapter of prosperity to the motion picture industry, and have helped to bring about a renascence of the business.

It is a pleasant duty to acknowledge my thanks to the film trade press, the engineers of the Bell Telephone Laboratories, the Society of Motion Picture Engineers, and the technical departments of the Fox West Coast Theatres, for many of the facts contained in this book. It is hoped that as a treatise the volume will be helpful to those interested in the progress of the new art.

Los Angeles, 1929 H. B. F.

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Part One

A HISTORICAL SURVEY

CHAPTER I

THE COMING OF SOUND

SOUND, to the motion picture public, is a new thing. To the leaders of the industry it is not. I am referring now not only to the recent period during which commercial sound pictures were being prepared, previously to showing or even advance notice, but to the much longer period during which inventors and technical companies were grappling with the special problems of the dream which is at last a reality. Every step of the struggle was known to those of us who knew the need of following it. Occupied though we were with another and a gigantic task—the development of the moving picture from a "store show" to the rank of fourth in the nation's industries—we nevertheless had eyes and minds to follow the beginnings of the next phase of our calling. Therefore, when that phase reached the point of practicability there were hands ready to welcome it. It is indeed with real pride that I recall, from my earlier work, *Motion Picture Theatre Management*, the confident prediction for the new movement, that it would go into realization with swift strides. It has done so, beyond denial; and I venture to supplement that earlier forecast with this—that it has come to stay.

Now, one result of watching the advance of sound in its obscure preparatory days has been that the industry was ready to accept and adapt it as soon as the proper moment arrived. As you see, the moving picture is a modern industry, not only in being contemporary, but in conducting its business along the most enlightened and up-to-date

lines. When the time comes—and it will!—that ushers in the next great element of the art, the captains will again be prepared to startle and please millions of patrons with an added improvement.

Another advantage of that vigil of many years is that, instead of being taken off guard by a novelty, we were in large degree acquainted with its findings as well as with its flounderings. Hence the possibility of a text like the present, so early in the game. Our knowledge of sound, tentative and liable to change though it be, is already considerable. The experiments and conclusions of engineers, producers, distributors, and managers form a body of fact awaiting only the expression. Indeed, it is a question whether our age is the more remarkable for the speedy distribution of new machinery or the equally swift distribution of information thereon. We are a race quick alike to create and to teach; and the fact that "we" includes our own field, as well as any other, may rightly be a source of pride and pleasure.

Therefore, before we enter into the special exposition of sound pictures, to share the knowledge and the experience of this new phenomenon, let us first peep behind the scenes for a glimpse of that story which the leaders have been following for half a century.

In 1894 Edison invented the cinematograph. Eighteen years before, in 1876, he had perfected the phonograph. It is interesting to note, further, that in 1887 Edison stated that he was attempting to devise "an instrument which would do for the eye what the phonograph does for the ear, and that by the combination of the two all motion and sound could be recorded and reproduced simultaneously." At length, in March, 1913, Thomas A. Edison presented the Kinetophone, which was the realization of the principle. The pictures were synchronized with phonograph records, but the listener used ear tubes. The device

was exhibited for several months in 1895 at Raff and Gammons' "Kinetoscope Parlor" in New York, but eventually the exhibition was withdrawn because the public preferred the silent Kinetoscope.

No whit daunted, in 1910 Edison used a device consisting of a phonograph on the stage, coupled by a wire-driven belt with the projector in the booth, in an effort to obtain synchronized sound effects with pictures. The entertainment ran for some sixteen weeks in the B. F. Keith theatres, but had no further commercial success.

On February 9, 1897, a U. S. patent was granted to George W. Brown providing for the synchronization of a phonograph and motion picture film.

In 1901 Gaumont & Cie secured a French patent providing for the synchronization of a phonograph with a projection machine. In 1902 and 1903 French patents of addition were issued providing for an improvement of a synchronization device, as well as providing for a series of loudspeakers attached to a phonograph by electrical wires, and the patent suggests that the loudspeakers may be moved in back of the screen so as to follow the movements of the players.

On July 31, 1899, a patent was issued in Germany to L. A. Berthon, C. F. Dussaud, and G. F. Jaubert for an apparatus in which a projection machine and phonograph are synchronized. In 1903 a German patent was issued to the Messters Projection Company for a device coupling a projector to a phonograph.

In 1907 a French patent was issued to Georges Pomarede covering synchronization by means of a flexible driving shaft between projection machine and phonograph. Similar patents were issued in the United States to L. S. Stiles in 1910.

The Cameraphone, brought out by Whitman in New York in 1904, may be said to have attained the first real

commercial success of synchronized sound pictures. The film in this device was synchronized with a phonograph disk record similar to the disk system now in use, and the effects obtained were harmonious but, unfortunately, without amplification. Though the device was used for several years its novelty eventurally wore off. After all, it was but a phonograph, and of no higher standard than the type of talking machine which people had in their homes.

About the same time Jaumant's Cronophone was shown in certain parts of Europe. This mechanism also used disk records, but with a motor operated by a spring, and was synchronized to the projector. A similar device was shown in this country in 1905, but it never attained any commercial success.

It is apparent, from the foregoing, that the development of sound pictures is based on the earlier efforts of Mr. Edison. Thus the screen has advanced, from the birth of moving pictures to the present development of talking pictures, in the fertile brain of the Wizard of Menlo Park.

Other experiments in sound photography were conducted more than half a century ago. Czmark of Vienna in 1882 photographed the vocal cords in action. In 1888 Professor Blake of Brown University photographed the vibrations of a microphone diaphragm through a beam of light on a photographic plate, which was kept in motion by a clockwork mechanism. Several years later Professor Herman, at the International Congress of Psychology, at Liége, Belgium, used a microphone in connection with a phonograph, the sound being recorded photographically on sensitive paper. To his microphone Professor Herman adjusted a small mirror which vibrated or oscillated in accordance with the sound produced by the phonograph records, the beam of light from the mirror varying accordingly. His device is of interest because an oscillating mirror is to-day one of the important steps in recording sound on sensitized

material used in one of the standard "sound on film" recording and reproducing systems—the R. C. A.-Photophone. Professor Herman, however, used sensitized paper, not film.

Demeny's "Chronophotophone" was brought out in Paris in 1892 and showed the first real talking picture. It consisted of a series of lantern slides for projecting the picture on the screen, combined with a lantern and a cylinder phonograph and mechanism.

The beginning of the sound pictures of a photographic combination of synchronized sound and action on film came in 1906 when Eugene Augustin Lauste, an electrical engineer, who was employed by Edison as well as the old Biograph Company in experimental work, filed an application for a patent in London, which was described as follows: "A new and improved method of a means for simultaneously recording and reproducing movements and sounds." A patent was granted to Lauste in 1906 on the records of the British Patent Office. The preamble in the patent office reads:

> It has been proposed to patent No. 18057, A. D. 1906, a device to record simultaneously the movements of persons and objects, and the sounds relating to them optically upon the same photographic records running side by side with, and at the same rate as, the image is received.

This description makes clear the importance of Lauste's disclosure in the light of claims which have since been made relative to sound pictures and their development. The Lauste device was called the "Photocinematophone," and the method was demonstrated in London on several occasions, at which voice and music were photographed simultaneously, while the action was recorded on sensitive negative film. Lauste was the first to employ the selenium

cell in this method; and, as far as is known that was the first use made of it.

From this it may be seen that Lauste holds the distinction of establishing the master patents through which the sound on the film pictures of to-day have been made possible. It is interesting to note that at this writing Lauste is alive and active, although past seventy years of age. It is understood that he is in somewhat straitened circumstances, for he has spent in excess of $100,000 in his effort to have his invention recognized. Even to-day he is steadily continuing his experiments in a little workshop in Bloomfield, New Jersey. His present hope is to develop a new type of amplifying device which may prove as revolutionary as his earlier inventions in the picture field.

In 1917 a United States patent and a number of foreign patents were granted to William H. Bristol for an entertainment apparatus, combining motion pictures and sound records synchronized by what was known as the "Michalke" device for transmitting motion. A score or more patents have been issued in many countries. Most of them have now expired and are in the public domain.

In 1921 Sven Bergland, of Stockholm, Sweden, showed a device for talking pictures there. In 1922 Vladimar Tovelson, of Denmark, announced some discoveries in the synchronization of sound and photographed action. In 1923 Dr. Lee DeForest presented sound pictures which were shown in several theatres. The DeForest method is understood to parallel the system employed by Lauste. That is, through the use of a photo-electric cell, the sound light ray is imprinted on sensitive photographic film coincidentally with the photographing of the action. While DeForest used the same means to make the sound record as Lauste, his method of reproduction differed in that he employed radio tubes. These amplified the light ray that electrically reproduces the variations of the photographed sound.

The sound-on-film method received its greatest development through the effort of William Fox, who formed an alliance with Theodore W. Case and brought to perfection the device then known as "Movietone." Recently another inventor, F. V. Madelar, developed another method of sound-on-film recording, whereby the picture is recorded not on the emulsion side of the film in the usual manner, but upon the unsensitized or plain side of the film strip. By use of a diamond stylus the sound is photographed on the film in the form of a waveline record similar to the recording of sound upon a disk. Then an electrical circuit is employed to pick up the sound on the film, which is reproduced through cone speaker.

The method is similar to that perfected by James H. White, of the Edison Company, in the early part of 1900.

In December, 1926, the DeForest Phono-Film Company produced a one-act melodrama called *Retribution*. It was two reels in length and ran about thirty minutes. To my knowledge it was the first entirely talking picture ever made. Another "talkie" was one made for the American Bell Telephone Company, depicting Professor Bell, first testing his first telephone in his laboratory, and later showing it to Don Pedro, Emperor of Brazil, at the Centennial in Philadelphia in 1876. This picture was given to the public almost immediately after the DeForest production. It was made, however, by the disk process instead of by the film. It was part of the company's exhibit at the Sesquicentennial in Philadelphia.

It is the invention of the microphone, brought about in the development of the condenser transmitter used in telephone work, that has made modern recording possible. This microphone was developed by Dr. Edward C. Wente of the Bell Telephone Laboratories.

In recent years sound synchronized with motion pictures has received its greatest impetus through the efforts of

the Bell Telephone and General Electric laboratories; and the present commercial success has been effected principally because of the perfection of amplification. While pictures synchronized with sound were possible before, the reproduction was not of a quality to make them acceptable to the public. Now, however, the earlier problems have been solved, and sound synchronization is at last a commercial success. Similarly, it is believed, study and experiment will make of the various sound synchronization devices a perfect apparatus that will faithfully reproduce in any theatre—no matter how large—the subject which is to be recorded.

Thanks to the miracle of the new art, the screen takes voice and life. Titles give way to actual dialogue spoken from the lips of the players. The phantom figures of the silent screen become real characters of flesh and blood. They live—they talk—they sing—just as in real life!

Hence sound synchronization is bringing to the motion picture theatre a second chapter of progress, not only because of the great delight shown by the public in the art form itself, but because of the re-created interest that it has brought about within the industry. The advent of sound or talking motion pictures has resulted in quickening the pulse of the entire profession. Originally, the motion picture held popular sway in the field of entertainment because of novelty alone. As the public, however, became accustomed to seeing motion pictures, and the novelty wore off, the products earned their due and were judged by their entertainment value and the quality of the offering. The coming of sound in motion pictures has therefore stimulated the industry, not only because of fresh possibilities on account of sound, but because of the renewed effort being made in the production of silent pictures. All of us have been aroused to new enthusiasm and stirred to new and greater activity, with results that benefit the

public as well as the trade. Those who welcome progress welcome this new art and will plunge eagerly, studiously, and enthusiastically into the task of promoting it to higher levels. As a result we are unquestionably facing a period that will see not only a continued development of sound motion pictures, but also a raising of the level of silent pictures.

There is little question that the technique of the making of pictures will be affected by the introduction of sound, yet the silent motion picture is too well established as a medium of entertainment to vanish because of the new development. It is more likely that the motion picture theatre of to-morrow will render both types of entertainment. There are a number of reasons for offering such a prediction. First, many stories and situations are of a type that do not lend themselves to proper interpretation through speech. This is particularly true of the type of picture which must find a world market, where the problem of different languages raises a barrier. Secondly, the popular star of to-day represents a huge investment of proved screen value, and it would be poor judgment to scrap such talent. Players of personality and charm will continue to find public favour. Finally, there are many patrons who prefer the restful atmosphere and soothing effects of silent motion pictures with no more than musical accompaniment.

Through sound synchronization, on the other hand, a new literature will be brought to the screen. Fresh advances in the technique of motion picture creation, that will appeal to the ear as well as the eye, will make possible a novel mode of expression. Just what, or how, we cannot now say. No one can estimate at this time the far-reaching effect of such a development. Yet one may venture to suggest that the technique will take the best practices of the stage as well as the screen; and that out of it all will evolve

an entertainment of the widest possible scope. Decidedly, the great motion pictures are still to be produced. For one thing, directors will devote their best efforts toward securing the right touch in the tone and shading of speech. It seems likely, too, that the new mode of expression will bring to the screen new faces and personalities who, because of power or charm of voice, will lend themselves to a new device. Just as radio has developed a talent all its own, it is likely that sound motion pictures will call into service personalities recruited entirely apart from the stage or the motion picture.

At any rate, great progress has already been achieved in the making of pictures that have talking sequences even as compared with the crude efforts *of a few months ago!*

Technically, sound synchronization is in capable hands, and fundamentally it may well be said that the various devices have perfected the recording and amplification of voice and sound. It is to be expected that further improvements and betterments will come out of the laboratories of the electrical companies that are fostering these instruments. Up to the present stage it has been found that the most practical installations are those which are fostered by the Electrical Research Products, Incorporated, and the R. C. A.-Photophone. In addition to these, other devices, such as DeForest Photofilm and the Bristolphone, are making strides in placing machines in theatres. Some of these have merit and will find a place for themselves. Because of the fact that virtually 90 per cent. of the motion picture producers have committed themselves to the Electrical Research device, it is recognized that that apparatus has a big initial advantage. It is known that the Electrical Research company has a close association, through license grants, with such organizations as Fox Film Corporation, Warner Brothers, Paramount Famous Lasky Corporation, First National, Universal, United

Artists, and others. Through the medium of Movietone and Vitaphone, which records the sound on the film itself, as well as on records, these producers are now making a product which will eventually be shown in theatres that are equipped with Electrical Research apparatus, although such productions may be projected and heard on other apparatus, too.

Primarily, to insure for itself a ready and national market for its apparatus, the Radio Corporation of America, through a partly owned subsidiary, the Radio-Keith-Orpheum Circuit, entered the industry as theatre operators as well as motion picture producers. A new sound studio is now being completed by R. C. A., a radio affiliated organization, so that a production schedule may be maintained. The R. C. A.-Photophone device is now being used by Radio Pictures, Pathé, Tiffany-Stahl Company, and Educational Pictures Corporation, who have formulated ambitious plans for producing their own pictures, to insure for Photophone users a steady flow of the product.

The position of the Radio Corporation of America in the motion picture industry was recently further strengthened by absorbing the Victor Talking Machine Company, which gives them access to talent of a type that has proved successful in recording. The most capable artists will thus, naturally, become available for sound pictures as well as broadcasting. It is apparently the further purpose of the R. C. A. to build up an entertainment that eventually may have the elements of radio motion picture and television.

One of the principal problems that face the industry at this time is the question of interchangeability of films and records for the various devices that are being manufactured.

There appears to be little question that interchangeability will be permitted by the manufacturers of Movietone,

Vitaphone, and Photophone. Whether these companies will permit their apparatus to be used in connection with other sound-reproducing devices will depend to a great extent on whether such mechanisms infringe on the Western Electric or General Electric patents. This is a legal question which will be settled in the courts. On August 7, 1928, Mr. David Sarnoff issued the following statement for the R. C. A.-Phonophone:

> As a convenience to exhibitors and with a view to obtaining complete interchangeability of sound films made by the Movietone and the Photophone processes, R. C. A.-Photophone has now adopted a sound track eighty miles in width, but retaining the Photophone method of recording. Tests made in studios and theatres with a variety of sound motion picture subjects prove conclusively that Photophone films not only play interchangeably on movietone projectors, but also give normal and satisfactory speech and musical quality perfectly synchronized. The eighty-mil Photophone sound track requires no modification whatever of the Movietone sound projector; neither is the operating procedure of Movietone changed in any way.
>
> I know of no reason, technical or otherwise, why sound films recorded by the Photophone process cannot be satisfactorily played on either Photophone or Movietone machines installed in theatres. Also, the Photophone Company has no objection to sound films recorded by the Movietone process being played on Photophone machines installed in theatres.

There appears to be little question that interchangeability, by reason of economic expediency, will automatically become a fact throughout the industry. Had the silent picture originally operated with different types of projection machines running various widths of film, the progress of the entire industry would have been arrested. Sound talking apparatus can be likened to that of the motion

picture projector, and all who have the future of sound at heart will recognize this fact. It is the opinion of the present writer that in the final analysis the machines that do not allow for interchangeability will eventually lose their market.

In due time the different types of sound apparatus will most likely be reduced in number to those few which are fostered by organizations that have the resources as well as the better type of equipment. Surely there appears little doubt that interchangeability of such equipment will be one of the conditions under which it will be possible for them to exist. Though the manufacturers of the machinery may not entirely agree at this time, it will be found that in the long run the only thing that will count in sound motion pictures will be the picture itself, and not the specific apparatus which is used. Shakespeare summed it up when he wrote "the play's the thing," and his judgment has been right through all the ages in the history of the theatre. We have no reason to believe that the future will prove him wrong. It is likely that, in the long run, patent infringement suits will establish a limited and standardized equipment.

Thus science seems to have done its part. Now it remains for those within the industry to foster our latest development, made possible because of the recent new medium of creative expression. What, in the simplest terms, does the medium amount to? This: we have open to us another sense; we are permitted to exploit an additional power of the human being. For more than a quarter of a century we have wielded an instrument of amazing potency to charm the mind through the eye. We have cast shadows on a screen, and the millions have come to laugh, to weep, to learn, as at the command of magic. Since every normal eye sees what it sees, our phantom speech has become universal language. That the ability to play upon one of the

senses is a field of enterprise our record already demonstrates beyond quibble.

Now our stock-in-trade would seem to be doubled. Within the limitations of nationality to which I have already referred we shall in the next decade be enabled to add to our appeal to the patron's eye the powerful auxiliary of all the possibility for enjoyment that waits in his ear. To a certain degree we have always attempted this. From the lone piano of the "store show" era to the symphony orchestra of to-day we have provided an accompaniment of pleasure not visual. In addition, we have simulated the sounds of hoofbeats, of railway engines, of taxi horns, to tease the mind into further acceptance of the eye's illusion.

To these elementary effects now are added the mechanical agencies of an epoch of machine making. Outside the theatre our audiences have been made ready for the acceptance of contrivances appealing to auditory reception. The talking machine has established its own realism. In spite of the fact that Caruso is no longer among us, we say that we are still "hearing" him "sing" from *La Bohême;* we mention the record only in passing. During the recent campaign we "heard" the candidates, who spoke sometimes half a continent away. We have come to respond to the mechanized sounds as to the original, because of that basic illusion, bred in us from childhood, that we can "converse" with a distant person over the miracle whose household name is the telephone.

This acquiescence in a mechanically produced sound as a real, original sound prepares the race for something new in entertainment. Some people speak warningly of "a necessary period of public education." It will be a brief one. It is already almost a finished one. The public are with us. So, too, are the artists of the word spoken or sung. Performers, writers, composers—they flock anew to our studios for unprecedented rewards in exchange for

varied gifts. In this way alone the infusion of new blood is simply incalculable. Nor can I see how, in the long run, the movement can fail to be international. It is not necessary to advance visionary arguments in defense of such a belief. We may, or may not, live to speak and hear a universal language. Nations may, or may not, become more and more conversant of each other's idioms. Neither of these is an impossibility. Neither of these would be necessary. Translation and adaptation are old tricks quite handy for the new trade. Or some eventuality, not dreamed of now, may cut the Gordian knot.

Regardless of the outcome, the beginnings traced in this chapter give indication of a world-wide movement. Once again inventiveness has ignored boundaries. Look back over the record I have presented and note how the whole civilized world has been represented in this conquest of matter by mind. Because of superior national wealth and industrial organization, our country is in the van. There can be no doubt that we shall continue to deal with the new resource and that we shall spread over the face of the globe the advantage of the mechanisms involved. We have traced their evolution. Now let us see what they are.

CHAPTER II

THE GROWTH OF SOUND

I. The Attitude of the Industry

Although a generation was required to develop devices for sound, it has taken only three short years for nation-wide acceptance and application. True, conservatism waited for the "other fellow" to try the invention and take the risk. When one considers the stake involved the reluctance was humanly understandable. Here was a step without precedent, to be made at a moment of acute crisis within the industry. The cost of trial would be considerable; failure would involve not merely the immediate loss but the imperilling of considerable investment in silent pictures. The great companies were compelled to consider several questions, each as unanswerable as the riddle of the Sphinx, and all together constituting a veritable chaos of conjecture. Was sound, first of all, a fad or a practical venture? Was the time ripe? Was the new device to supersede the old, to grow side by side with it, to be linked or merged with it? Finally, which one of the many systems was the likeliest to prevail? Surely a complex of bewilderment!

How the Gordian knot was cut, and by what agencies, I shall come to presently. What concerns us at the moment is that, once the answer was even partially apparent, the industry turned its face and mind and hands to the task of the future. The motion picture has been called one of the giants of our age. To suit the epithet it donned seven-

league boots, and its strides into the virgin territory have been beyond prophecy. In fewer than fifty months a mammoth industry has undergone a convulsion of changes too numerous to record. Studios are no longer the same. The very theatres are different. What was up-to-date equipment the year before last is now pathetically antiquated. Even the kings and queens of the screen are threatened by newcomers, many of them still to be tested in the fires of public choice. Nor is the period of transition in any way approaching an end. The upheaval goes on; all eyes are still ahead; all energies still tense for quick decisions, for breathless conjecture.

There is, of course, nothing surprising in all this. We know that you can't make an omelette without breaking the eggs. The surprising fact is that, amid the shouting and confusion, there has been maintained a steadily growing volume of production, balanced by an equal development in exhibition, and carried throughout the length and breadth of the land. The production schedules of sound pictures are beginning to keep pace, if not to vie, with those of the silent product. First- and second-run houses are rapidly installing apparatus. There is no major territory not enjoying the refreshment of the novelty. The voice of demand is heard in every state.

What has the industry done—what is the industry doing—to provide and to increase the supply?

Let the record answer.

II. Vitaphone

In 1925 Warner Brothers, as I have said, became interested in the possibilities of the disk recording and reproducing device which had been developed by the Western Electric Company through the Bell Telephone Laboratories. Although this mechanism had already been

offered to several of the large film companies, all of them had rejected it. On August 7, 1926, after some months of preparation, the name "Vitaphone" was adopted as the trade-mark of the apparatus, and it was given its first demonstration by Warner Brothers in their New York theatre.

For the opening programme Mr. Will Hays appeared on the screen and, in words perfectly timed to the motion of his lips, greeted the audience and expressed the belief that Vitaphone would revolutionize the motion picture industry. Thus the invention announced its own destiny and compelled the realization that commercial synchronization of motion pictures with voice and music was practical—had graduated from the laboratory. The same programme included Martinelli, Marion Talley, and other operatic stars; and to indicate the range of possibilities, there were Negroes playing instruments, and some bits of comedy. Then, the crux of it all, the feature picture, with its synchronized musical score, appeared. It was *Don Juan*, an instant hit, greeted by an enthusiastic audience. The experience gained in these recordings later paved the way for the development that was to come. Meanwhile, Vitaphone had arrived!

Following the first effort Warner Brothers entered upon a regular production schedule of short subjects in which the characters spoke and sang. To these effects were added others of special synchronized sounds. The innovations not only made possible a diversified programme of short subjects, but gave to Warner Brothers an invaluable experience in the handling of the new sound-reproducing device. In character the short subjects varied from vaudeville numbers to multiple-reel features and comedies. Among the stars included were performers as well known as Elsie Janis, Adèle Rowland, the Foy Family, Eddie Quillan, Bessie Love, Edward Everett Horton, and many

other artists of the stage and screen. Yet while these offerings were accepted with interest by the public, the final financial results were not entirely satisfactory, for one simple reason: the number of theatres equipped with sound-reproducing mechanisms was still limited.

Success, however, lay not too far ahead. The turning point in the fortunes of Warner Brothers, and it may be said of the talking picture, came with the presentation of Al Jolson in *The Jazz Singer*. It is interesting to note here that only through accident was Al Jolson given the opportunity to make theatrical history. Warner Brothers had acquired *The Jazz Singer* and had cast George Jessel to play the part in which he had been so successful in the stage version. A difference of opinion arose between the management and the player; he felt that he was entitled to additional remuneration, since he was to sing and talk in the screen version, which had not been anticipated. The dispute became a deadlock; Al Jolson was engaged for the part, and the result is history. Mr. Jolson sang a number of songs most effectively, and there were certain scenes which contained spoken dialogue. Never before in the annals of the theatre world had there been a success so instantaneous.

Al Jolson in *The Jazz Singer* made a very substantial contribution to the public acceptance and further development of the art. One scene alone showed that here was a new method of expression, pointing the way to great possibilities of the most recent art. It is when Al Jolson, playing the piano and singing "Blue Skies" to his mother, is "ad libbing" or improvising remarks to her between choruses. The monologue, spoken with the inimitable Jolson throb, afforded in one little simple scene more effective drama than had ever been conveyed by any silent picture. The possibilities of the talking cinema now became apparent. Progress in production has since been

extremely rapid, particularly in the methods used in the making of pictures. The original provided the clue, and the clue has multiplied to a semblance of technique.

Before the filming of *The Jazz Singer* only one person could be filmed on a set at a time, and very little space could be allotted to him. In this production, however, microphones were placed in many positions, so that characters could move about with greater freedom. More attention, likewise, was paid to details and settings, thus making it possible to use much of the screen technique of the silent motion picture, which had been ignored in earlier attempts.

With the success of *The Jazz Singer* Warner Brothers concentrated on the making of sound motion pictures containing dialogue. The result is the production of a number of talking sound pictures which have met with great financial reward, and which have proved to be a great stepping-stone in the fortunes of the organization. Among the early productions which met with box-office success were *Tenderloin* and *Glorious Betsy*, which had certain sequences filmed with dialogue. Encouraged by the reception of these pictures on the part of exhibitors and the public, they then produced *The Lion and the Mouse*, the first picture containing 50 per cent. of talking dialogue. The cast included Lionel Barrymore, May McAvoy, Alec B. Francis, and Willie Collier, Jr.

Shortly afterward they produced *Lights of New York*, which was the first all-talking screen story, in which every one of the characters spoke lines throughout the entire film. The cast included Helene Costello, Cullen Landis, Wheeler Oakman, Mary Carr, Thomas Dugan, Robert Elliott, and Gladys Brockwell.

Naturally, experience was gained in the screening of these pictures, and much was learned as to voice requirements. Subsequent Warner Brothers' productions have

evinced the benefits of these findings. It may be of interest to note that while Warner Brothers used players from the stage as well as the screen, they found in most cases that the players with motion picture experience were more adaptable to this new art because of their knowledge of motion picture technique; for while stage artists possessed something of an advantage in the reading of the lines, they did not always screen so well as the cinema player. On the other hand, as was only to be expected, the motion picture actor approached his new task with a certain timidity, which has been overcome in a measure, and will continue to be, with experience.

For these and other benefits Warner Brothers may be given due credit. They helped to establish the foundation on which the talking picture will continue to progress. That record is theirs—and one of which they may well be proud. Now let us see what others have added.

III. Movietone

About the same time that Warner Brothers became interested in the Western Electric system of sound, William Fox, president of the Fox Film Corporation, sensed the tremendous possibilities of the mechanism. He formed an alliance with Theodore W. Case, an inventor of standing, who had previously been associated with Dr. DeForest in some of his experimental work in developing Phonofilm. For more than four years Mr. Fox made available large sums of money in financing Movietone research work, in general experimentation, and in the perfecting of details. To this day the Fox-Case corporation is probably the only organization affiliated with a film-producing firm that maintains its own research laboratories for the development of new inventions for the motion picture industry. Among other researches, a considerable part of the practi-

cal development of the variable density sound system, whereby recording is accomplished by photographing the sound on the film itself, may be attributed to the efforts of the Fox-Case Laboratories.

In 1927 the Fox-Case Movietone became the trade name for the photographic recording producing system. Shortly afterward it was incorporated into the Western Electric sound system, in conjunction with their own Vitaphone development. From this point on, the Western Electric sound system was made available by photographic recording on film as well as on disk. The success of the apparatus was instantaneous, and has since led to a popular demand for synchronized sound screen entertainment.

Again science has triumphed! It has given voice to the motion picture, which seemed destined, by its very success, to remain forever a voiceless medium of expression. Through the newly improved Western Electric system the synchronization of picture and sound was made possible, with a faithful reproduction of both and with the whole world as its stage. Even in an age of mechanical and artistic marvels the sound picture has made a notable début. A public which watched the motor car, the airplane, the motion picture, and the radio develop from crudity to their present high achievement gave the sound picture a kindly reception.

The faint rustle of leaves, the chirp of birds, the distant bark of dogs, the beat of horses' hoofs, the whirr of the airplane aloft, the boom of the surf, the patter of rain, the echo of thunder, the crackle of burning wood—all the sounds of outdoors, which may not be conveniently recorded by the disk method, are heard with startling fidelity, clarity, and naturalness through the medium of Fox Movietone. In addition, every advantage of studio recording was also made available, so that now we can

not only see our favourite stars of stage and screen but hear them as well!

Once established, the Fox Movietone was developed rapidly. The first subject exhibited publicly was one in which Raquel Meller, the famous Spanish artiste, appeared in a cycle of songs, on January 21, 1927, in conjunction with the showing of the Fox picture, *What Price Glory*. On May 25th of the same year the first complete Movietone programme was given in New York, in conjunction with the showing of *Seventh Heaven*, a Fox picture of distinction. It was produced by Frank Borzage and featured, and subsequently made stars of Janet Gaynor and Charles Farrell. On December 31, 1927, the initial regular issue of Fox Movietone News, the first talking news reel, was released. Through this new medium it was possible not only to see the face of the world's news, but to hear its voice, too. To-day the world's greatest celebrities speak to the world through the Fox Movietone, from the four corners of the globe. Royalty in the persons of King George of England and King Alfonso of Spain, and international figures like George Bernard Shaw and Mussolini, are brought to the people of every land. A world-wide organization of news-reel crews records important events throughout the globe. Fox Movietone quickly became a weekly feature. It was so well received by the public that two issues weekly were introduced, and afterward three weekly issues. It is the object of Mr. William Fox further to multiply the releases until a complete talking news reel will be shown every day!

The first feature film in dialogue produced through the medium of Movietone by the Fox Film Company had its première on June 18, 1928, at the Globe Theatre, New York. The programme included *The Air Circus*, together with the first comedy, *The Family Picnic*. The first outdoor talking picture was *In Old Arizona*, also a Fox production,

which was presented initially at the Fox West Coast Criterion Theatre, Los Angeles, on December 25, 1928. This film was photographed and recorded outdoors against a sweeping background of natural beauty, and in it sound recording achieved its highest artistic success up to that time. Filmed and recorded right in the vast open spaces, the scenes and human voice and all the accompanying sounds were reproduced with a clearness and naturalness that attracted wide attention. The Movietone process caught and reproduced with fidelity not only the voices of the actors, but actually the natural sounds of the outdoors: the whispering of the wind, the song of the birds. The picture was thus notable in combining the perfected technique of the silent film with the faithful recording of music, dialogue, and sound.

Subsequent Fox pictures that were well received and that helped to advance the art of sound recording included the all-talking picture *Through Different Eyes*, and *Hearts in Dixie*, which was unusual because of the fact that it was reproduced with an all-Negro cast. It is probably the first musical offering produced as a motion picture would be, without the limitations of a proscenium arch.

The confidence that Mr. William Fox had in the future of sound and talking pictures took definite form in the erection of Movietone City, which arose from the cactus-grown waste land of Fox Hills, Los Angeles, and was built in ninety days. At the time of writing Fox's Movietone City is the world's largest sound studio plant, covering more than forty acres of ground. Here a staff of celebrated directors, authors, composers, and technicians has been devoting its efforts, under the supervision of Winfield R. Sheehan, to the development of the new art.

The studio consists of twenty-five buildings constructed of concrete. Four of them are 212 feet long by 165 feet

wide. In each of the four buildings are two sound-proof stages, making eight in all, each with its own equipment, apparatus rooms, test laboratories, and projection rooms. On one of the stages is a huge Wurlitzer pipe organ, especially equipped with every appliance and effect that can be used in the making of sound pictures.

Between the two pairs of stage buildings are others containing complete air-conditioning plants, for heating and refrigerating. Each air-conditioning plant has a capacity of 350 tons of refrigeration a day. As a result, it is virtually possible to manufacture in any weather and to assure ideal atmospheric conditions on any stage at all times, irrespective of the outdoors. There is also provided any desired humidity—a great boon to air conditioning.

The Administration Building is a structure 200 feet long by 60 feet wide, and is set off by a tower 75 feet in height. At the extreme rear of the walled city are two one-hundred-foot towers; one, the cooling tower for the air-conditioning system, and the other, the gravity tower containing water for the automatic sprinkler system, which is installed throughout the studio. A power house is equipped with huge generators that supply electric power for every requirement within the studio. There is a recital hall fully equipped for auditions, and in addition a test laboratory, a building for the film assemblers, a master projection room, and a wardrobe and property building. Dressing rooms are located in a two-story building 216 feet long by 50 feet deep. Close by is a garage that will accommodate a large number of cars. The carpenter shop, paint shop, and lumber yard are in one large building equipped with a construction platform. A special structure has been erected for the music library. A film storage vault, in which two million feet of film may be kept safely, and a fully equipped hospital with physician and surgeon in at-

tendance, are likewise part of this studio. Other buildings include police and fire departments. To add a crowning touch, the grounds are splendidly landscaped.

The Fox Movietone City was planned and erected under the direction of Mr. Sheehan, with C. H. Mulldorfer as architect and H. Keith Weeks as Chief Construction Engineer. The studio was dedicated on September 28, 1928. The Rev. Neal Dodd, pastor of the Little Church Around the Corner, and beloved of the film colony, gave the invocation, and Dr. Isadore Isaacson of the Hollywood Temple of Israel, and Rev. Father Joseph Sullivan, president of the Loyola University, spoke briefly. The completed studio stands as a monument to the faith of William Fox and Winfield Sheehan, who, because of their enterprise, are well equipped to face the future of the new development in the motion picture industry.

IV. Other Movietone Schedules

During the early months of the progress that was being made by Vitaphone and Movietone, as can be readily expected, the other important producing organizations made close study of the possibilities of sound, using the facilities of the Hays organization for a complete investigation of both the Western Electric system and what was then known as the General Electric system of sound recording and reproducing. After weighing the considerations offered by both systems, as well as considering the conditions imposed by those who controlled the devices, such organizations as the Metro-Goldwyn-Mayer Corporation, Paramount Famous Lasky Corporation, United Artists Corporation, First National Pictures, Incorporated, Universal Pictures Corporation, and a score of others, adopted the Western Electric sound system.

In May, 1928, these companies identified themselves

with what was destined to become the dawn of a new era in motion picture history. Their acknowledgment of sound pictures was a recognition that the novel device had arrived and had become an important part of the industry. In this way the best efforts of practically all of the important organizations within the industry were made available for the development of the new art. It did not take long for them to rush to completion fully equipped studios designed specially for the taking of sound motion pictures. Progress since has been extremely rapid, in the development of both studios and man power for the production of sound pictures, bringing to the motion picture the vast entertainment resources of the production brains of the industry. And it augurs well for the future of the sound motion picture that with few exceptions the initial effort of these organizations proved to be of high quality and enjoyed huge box-office receipts.

The first moving picture containing talking sequences released by this group was *Alias Jimmy Valentine*, with William Haines, produced by the Metro-Goldwyn-Mayer Corporation. Although *Alias Jimmy Valentine* had been completed in its silent version, Metro-Goldwyn-Mayer recalled the production and injected several effective talking sequences. The picture was shown at the Astor Theatre, New York, where it enjoyed a prolonged and successful engagement. To Metro-Goldwyn-Mayer likewise must go the credit for producing the first motion picture that combined colour as well as sound. This was a short subject that was released under the title of *Gus Edwards' Color-Tone Revue* and was shown at the Fox-Carthay Circle Theatre, Los Angeles. With even greater effect, Metro-Goldwyn-Mayer used colour in their splendid production of *The Broadway Melody*, which contained dialogue, singing, and dancing throughout, and proved to be an exquisite entertainment. This organization clearly

demonstrated that the addition of sound was a practical and successful adjunct to the motion picture, and was an embellishment that promised well for the future. Cecil B. DeMille, a Metro-Goldwyn-Mayer producer, who has achieved great prominence in the production of silent pictures, made as his first production with 100 per cent. dialogue a story called *Dynamite.*

In turn, the Paramount Famous Lasky Corporation organized a technical department that made a complete survey and study of sound synchronization. This resulted in the production of sound motion pictures which compared with the high quality type of motion pictures produced by that organization. The first Paramount picture that used sound was *Warming Up*, a Richard Dix offering that had been completed in its silent version. In its initial experiments with sound Paramount was content merely to add effects to that production. The first picture with complete dialogue was a screen version of *Interference*, which was shown simultaneously at the Criterion Theatre, New York, and the Fox-Carthay Circle Theatre, Los Angeles. This production was well received by the critics and had all the ingredients necessary to present a play with practically the same convincing fidelity it had enjoyed on the stage. Soon afterward Paramount released *The Doctor's Secret*, another stage play, and other productions that met with public favour, including *The Wolf of Wall Street*, *The Canary Murder Case*, *Close Harmony*, and others. It may be of interest to note here that the Paramount organization produced practically all of these pictures on an improvised sound stage, "shooting" many of the scenes during the night to obviate the intrusion of outside disturbances.

The United Artists Corporation, at the outset, introduced sound in several of its productions through the medium of musical accompaniment. The first photoplay

treated in this manner by United Artists was *The Tempest*, with John Barrymore. On the other hand, D. W. Griffith's *Lady of the Pavements* not only continued a musical accompaniment but introduced scenes in which Lupe Velez sang and danced. Shortly afterward there followed Douglas Fairbanks in *The Iron Mask*, and Mary Pickford in *Coquette*, both of which were awaited with great interest by movie "fans." In each case these productions introduced dialogue and brought to the cinema the voices of two of screendom's most beloved stars.

About the same time, Warner Brothers became associated in the management of the First National Studios, and as a result of their interest several First National productions were shown with both sound and dialogue. The innovation added materially to the value of First National's productions. The first of these was *The Barker*, which introduced several talking sequences with telling effect. This was shortly afterward followed by *The Divine Lady*, featuring Corinne Griffith. Soon Richard Barthelmess, in *Weary River*, Colleen Moore, Billie Dove and other First National stars added their voices to the screen.

Other organizations such as Universal Pictures Corporation, Columbia Pictures, Incorporated, the Hal Roach Studios, the Christie Film Company, and others, included in their schedules pictures that contained both sound and dialogue. The entire field was won.

V. R. C. A.-Photophone

The first public demonstration of the R. C. A.-Photophone was given under the name of "Kinegraphophone" at the State Theatre in Schenectady, New York, in September of 1927, before an assembled group of newspaper men and technical engineers. The demonstration included a short introductory speech, several musical numbers,

including a mandolin and banjo quintette, a contralto solo, a string quartette, a harp number, and a musical selection given by the General Electric Band. The development of this device represents several years of experimental research work in the laboratories of the General Electric Company.

The R. C. A.-Photophone, Incorporated, a subsidiary of the Radio Corporation of America, was then formed to exploit the sound system, and on May 14, 1928, this organization, through a page advertisement in New York and Los Angeles newspapers, announced the perfection of the apparatus. The advertisement was taken by many in the industry as an official notice of the Radio Corporation that they were entering the field of motion picture entertainment. Shortly afterward the Radio Corporation of America, through a subsidiary, the Radio-Keith-Orpheum Company, acquired the B. F. Keith and Orpheum chain of theatres throughout the country, as well as the F. B. O. Producing Company. Subsequently F. B. O. was changed to R. K. O., the initials of the names, Radio, Keith, Orpheum.

Through this producing organization pictures including sound were introduced to the public. The first efforts along these lines were limited to the presentation of musical accompaniment, and the first picture was *The Perfect Crime*, which, by the way, included some dialogue sequences. Important stage successes were acquired by the R. K. O. producing organization, including the very successful *Rio Rita*, which at this writing is in production.

On February 9, 1929, the R. K. O. Productions, Incorporated, announced that they had selected "Radio Pictures" as the trade name for R. K. O. productions, which is the motion picture producing and distributing unit of the Radio-Keith-Orpheum Corporation, sponsored by the Radio Corporation of America, the R. C. A.-

Photophone Company, the General Electric Company, the Westinghouse Electric & Manufacturing Company, and National Broadcasting Company.

In a statement, David Sarnoff, executive vice president and general manager of the Radio Corporation of America, declared:

> Beyond our functions in the field of international and other telegraphic wireless communication, it is our business to develop sound reproduction through the latest of the arts of electrical communication, thus the electrical group has established a great nation-wide service of broadcasting in the United States; it has coöperated with the phonographic industry in the creation of new sound reproducing instruments; it has now come to the motion picture industry to coöperate in the development of the new art of sound motion pictures.

An affiliation was subsequently effected with the Pathé Exchange, Incorporated, which adopted the R. C. A.-Photophone system of recording in the production of sound motion pictures. The first Pathé production shown with a musical synchronization was *Captain Swagger* with Rod La Rocque; and this was followed by several others in succession. It may be expected that before the year 1929 is completed these producing organizations will release several important contributions to the motion picture. The Pathé organization, in addition, has been releasing a talking news weekly recorded with the R. C. A.-Photophone process.

Other organizations that became affiliated with R. C. A.-Photophone at this time were Mack Sennett Studios, Educational Film Exchange, Incorporated, and Tiffany-Stahl Productions.

The acquisition of the Victor Talking Machine Company by the Radio Corporation is an indication that the

organization plans to interest itself in electrical entertainment of every type, including not only the sound motion picture and radio, but phonography as well. The huge resources of the organization, together with its fine man power, make it a unit to be reckoned with within the industry. Its entry into the motion picture field should help stimulate those already in it and should result in benefit to all.

There are several other reproducing devices being marketed at this time. It is not by any means the purpose of the writer to depreciate their importance by making no reference to them here. This chapter is intended to record only the progress of the organizations that have made certain contributions in connection with sound synchronization during the current, introductory period. Should the occasion present itself in a further portion of the text, I shall of course acquaint the reader more fully with the varieties of devices available.

Meanwhile, I pause for a moment to cast a retrospective eye over the two chapters that constitute the historical background of sound. First came the comparatively long period—actually but a generation—during which the inventors grappled with the problem of perfecting the means to the end. Then came the anxious months of doubt and hesitancy, then the success, and now we are borne ahead by the swift wheels of progress.

In the first chapter I referred only to the earlier apparatus. I have purposely refrained from detailed description of the mechanisms now in use, for I feared that the detailed exposition required might slow the pace of my story. Now, however, it is told; and I am free to lay before the reader an accurate explanation of the processes which are giving sound pictures to present-day audiences in present-day theatres.

Part Two

THE THEATRE

CHAPTER III

STANDARD SOUND DEVICES

I. Introductory

Before I explain, or even classify, the more important devices at present available, I must offer some general information. I shall make no reference to the fundamental theory. That belongs to the realm of the physicist, and its technical nature forbids inclusion in a text like the present. I am concerned with the facts as they may be observed by a clear intelligence and a somewhat more than average training. I am concerned with the applications that have been and are being made, right in the industry.

The word "sound," as we shall use it, has the special meaning of mechanically recorded and reproduced vibrations received by the ear while the eye is following a motion picture. Similarly, the terms "synchronism" or "synchronization" will be defined as the timing of such sounds to be simultaneous with the visual images they accompany. For example, the photographed movement of the lips in speech is not preceded or followed but absolutely accompanied by the auditory impression of words heard. The same is true of singing, of the playing of an instrument, of dancing in beat to music, etc.

There are two ways of effecting this simultaneity. The first, and the easier to understand, is the playing of a disk record in coördination with the unwinding of the usual familiar film. The second is quite different. It utilizes only film, but not the familiar kind. Or, at least, it is the usual picture film with something added. The new part, most

commonly, is a track alongside the picture. On this surface is a track or other marking which, when light is played upon it, releases vibrations that may be converted into sounds. How this is accomplished I will try to explain a little more definitely as the chapter goes forward.

Just as there are at least two methods of synchronizing so there are many commercial machines employing them. I intend to discuss only the Vitaphone and Movietone, the Photophone, the Phonofilm, and the Bristolphone, because it seems to me that these are the significant ones, and because in giving their details I believe I can best present the general subject. Later, in separate chapters, I shall take up separately the individual machines which, for one reason or another, would appear to merit detail in that fashion. For the time being, however, I present a broad survey, first for the layman, but equally useful, I hope, for the man in or entering the industry. The more detailed analysis, I feel certain, will be all the easier to grasp after such a preliminary background has been set up and comprehended.

II. The Western Electric System

The telephone is the foundation upon which the Western Electric sound pictures, in their present stage, have been reared. This recording and reproducing sound system represents several years of laboratory development. In the course of carrying on studies of communication problems, the engineers of the Bell Telephone Laboratories developed for the Western Electric Company the apparatus that bears the name of the latter organization. This apparatus includes, first, the public address system for amplifying and distributing sound; second, certain electrical methods of recording sound on phonograph records (known as "Vitaphone"); and, lastly, the recording

and reproducing of sound in conjunction with motion picture film (known as "Movietone"). Figure 1, page 41, shows cartoon diagram of Western Electric Sound Recording System.

The sound record comes to the theatre either as a wavy groove in a composition disk, which is practically a phonograph record; or as a marked track of varying density at one side of the picture film. It is the function of the apparatus to record and afterward to reproduce sound in perfect synchronization with the picture, so that the illusion of sound and motion picture are simultaneous, as I have said.

In the Vitaphone method the sound is recorded and reproduced from a disk made of a hard composition used in the making of phonograph records. This is operated in synchronization with the film, which is timed with the projection machine that projects the film on the screen. The disk records do not differ essentially from those used in the ordinary phonograph, except that they are considerably larger and are run at a much slower speed. The purpose is that a single record shall play throughout an entire reel of film. The reproducer used is similar, in some ways, to that used on the ordinary acoustic phonograph, the needle holder being connected to a clamp of the diaphragm. The diaphragm itself is made of highly tempered spring steel. To it there is fastened an armature of an alloy which is of especially high permeability and which is so arranged that, as the diaphragm vibrates, the flux in the air gap of a permanent magnet varies correspondingly. Thus there are induced, in appropriately placed coils, currents which are the electric representation of the wavy groove along which the needle travels.

With the disk method the first step in photographing and recording a scene is taken in a studio equipped with special facilities. These include one or more microphones

placed in or about the studio, out of range of the camera, near enough to the performer to pick up the desired sounds of orchestra, musician, speaker, or vocalist. Sound-proof booths house the cameras so that no outside noises may interfere with the procedure. When a scene is to be recorded the camera photographs it while the microphones pick up the desired sounds.

These sounds, striking the diaphragm of the microphone, cause it to vibrate. The vibrations are then translated into a fluctuating electric current that flows through wires to a control room. There the current passes through an amplifier system onto a recording device, and the fluctuations of the current are changed into mechanical vibrations which are recorded on a disk of soft wax. The procedure is therefore substantially that of making phonograph records. To make sure that the picture and the sound are perfectly synchronized, the motors which operate the cameras and the turntable carrying the disk are made to run at uniform speed and in perfect unison. These motors are started together; they reach full speed together; they continue to run together.

When picture and sound recorded by this method are reproduced in a theatre, the equipment employed is that made by Western Electric and known as the Western Electric Sound Projector System. A standard projector is used for the film. A turntable is added for the sound record. Both, however, are operated by one and the same motor; and means are provided to control the speed automatically. An adaptation of the Western Electric public address system makes it possible to pick up electrical vibrations from the reproducer, then to amplify them, and by means of loudspeaking telephones located in the theatre to transform them into sound. For the average theatre four horns, placed behind the motion picture screen, are sufficient for the purpose.

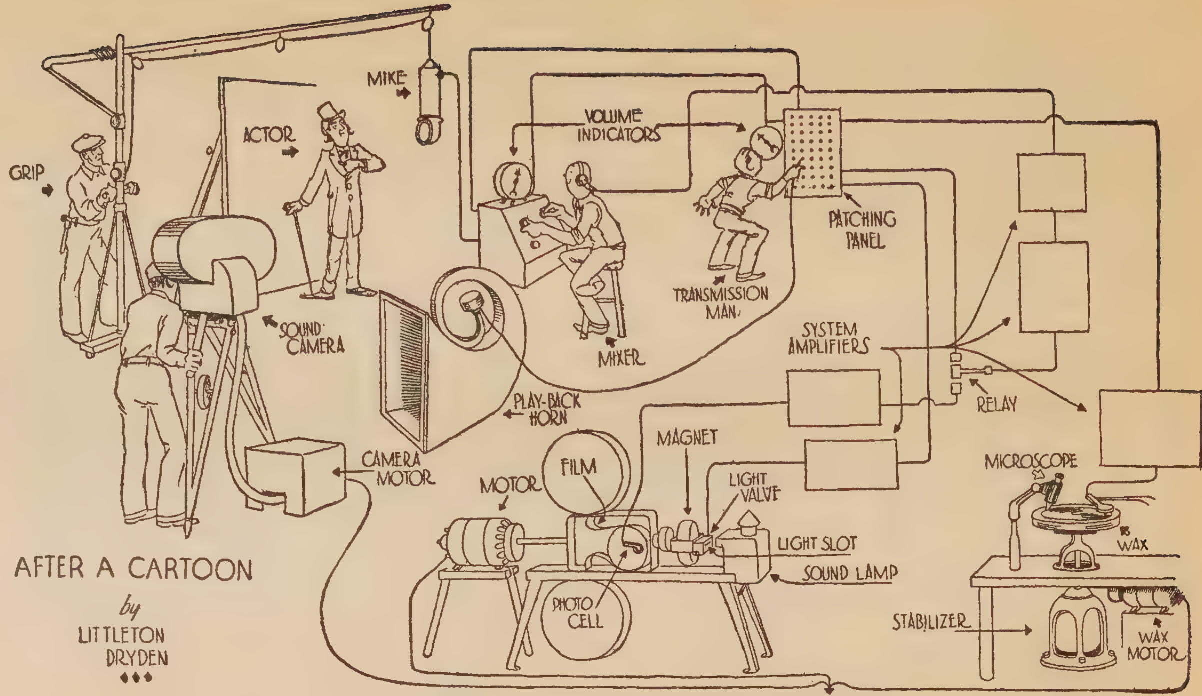

FIG. I. CARTOON DIAGRAM WESTERN ELECTRIC SOUND RECORDING SYSTEM

The film and the needle for playing the record are each set at starting points determined by marks made prior to recording the sound picture. The motor is then started and the film and the record are operated, in mechanical synchronization. The mechanical vibrations of the needle, as in the talking machine, are transformed into minute electric currents which are then amplified and finally transformed back into sound by the horns behind the screen.

The Movietone, or sound-on-film system, is photographed by means of light variations on the side of the film. The film sound record, as indicated, consists of a ladder-like band of microscopic lines or striations running along one side of the film. This sound track is 1.10 inches wide. The process consists in photographing variations in light intensity on the film. Differences or changes in intensity of sound are represented by differences in the density of light and shade, while pitch is represented by the number of changes from dark to light and back again in a given length of track. The sounds to be recorded are picked up by microphones which convert sound vibrations into electrical vibrations. These electrical vibrations are amplified and in turn vary the intensity of a recording light.

The sound record is converted into a corresponding electric current by arranging that a narrow, high-intensity beam of light shall pass through it and fall upon a photoelectric cell. The arrangement is shown in Figure 2, page 43. The light from the bright filament of the exciting lamp is focussed as a very narrow line upon the film by passing through a system of lenses and aperture plates. This recording light is contained in a tube that is inserted in the back of a camera in such a way that the variations in light intensity fall directly upon a narrow edge of the negative film on which the motion picture is also simultaneously being recorded. Aside from the fact that the

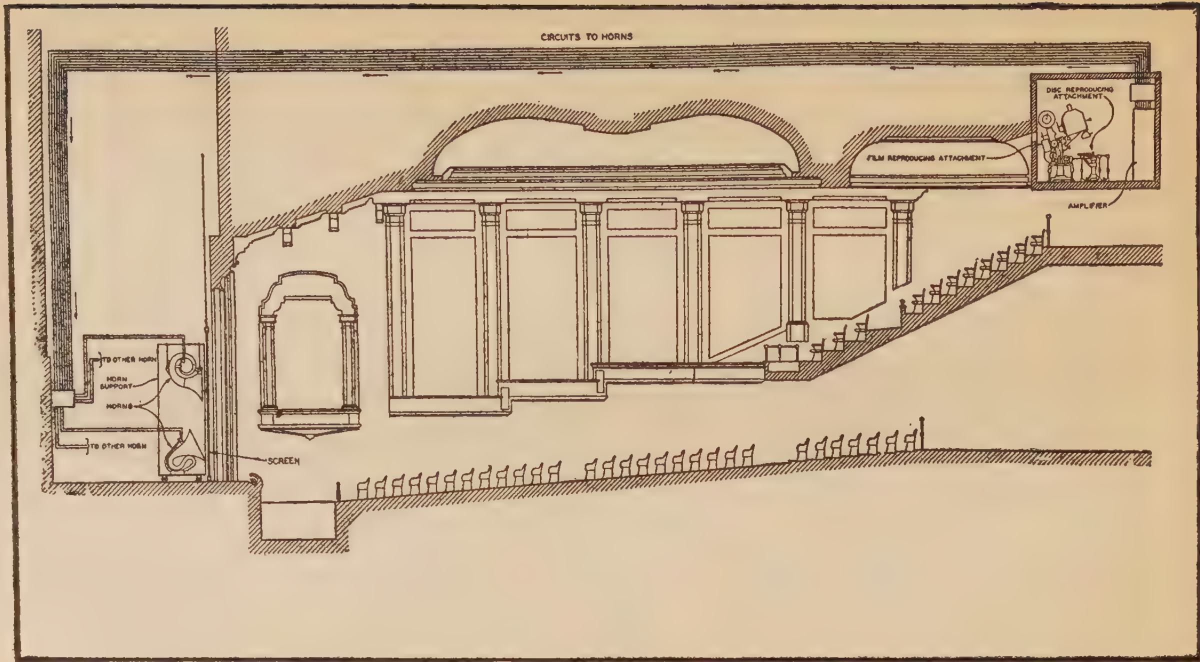

FIG. 2. SCHEMATIC DIAGRAM OF WESTERN ELECTRIC PROJECTION EQUIPMENT

camera is motor driven and is connected by wire with the telephonic apparatus, there is little difference between the recording of picture and voice by this method and the ordinary picture recording in a studio. This is called the "flashing lamp" method of recording.

The presentation of one of these sound pictures to an audience is in effect a reversal of this process. The standard film, containing both picture and sound in a photographic record, is run through a standard projection machine to which has been attached a sound reproducing unit. This unit includes a light that is reflected onto the sound record of the film. As the sound record on the film passes the light it interrupts the constant light shining through it and sets up light variations corresponding to those photographed. These variations then fall on a photo-electric cell which changes the light variations back to electrical vibrations. The latter variations, being too delicate to be heard directly, are accordingly amplified and carried by wire from the projection booth to the horns placed back of the screen, from which the sound emerges.

A main amplifier raises the energy of the feeble electric currents to a level adequate to supply the loudspeakers with sufficient volume to serve the specific theatre. As a step to follow the amplifier, there is an output control panel which consists of an auto-transformer, with a large number of taps. Each of the sound projectors or loudspeakers is connected to a dial switch, and these dial switches in turn are connected to the taps, so that each sound projector can be fed from any tap desired. Through this panel it is possible to make the impedance of the amplifier output suitable for the desired number of horns, in order to obtain the most efficient use of the power available, and also to adjust the relative volume of the individual horn.

It will therefore be seen that the only difference between

Vitaphone and Movietone lies in the pick-up apparatus used at the projector. In the case of the disk method we find that this embraces a turntable for the disk on which the sound is recorded; while in the Movietone method the equipment calls for a sound attachment unit. In theatres where it is desired to use productions made by both methods the projector is equipped with both turntable and sound attachment unit. The apparatus is known as the dual sound projector system and is employed in the greater number of existing installations. The closing of a switch is the only operation required to permit change immediately from one method to the other. The amplifiers and horns installed in the theatre are identical for both methods.

With ordinary pictures, in order to run a continuous programme it is necessary to use two projectors alternately, as a picture of one machine is faded into that on the other. So the sound record may be faded from one machine to the other without acquainting the audience with the fact that a change has been made. At the end of each record of sound film the music overlaps the beginning of the next, and a device called the "fader" is employed in making the transition. All that is necessary is to turn the fader knob when the incoming machine is started. In connection with the fader there is provided a switch for changing from the film to the disk system, and also a key for switching a separate projector in place of either of the regular machines.

The Movietone and the Vitaphone, under the Western Electric system, use the same type of horn and the same kind of receiver unit, which is specially designed for the purpose. The horns are twelve and fourteen feet long and are coiled. These are now being made in duplex form, and they are placed in back of a special screen. As indicated earlier in this chapter the ordinary theatre installation

employs four horns, two mounted at the line of the stage and pointed upward toward the balconies, and two mounted at the upper edge or above the screen and pointed downward. This arrangement has been found to give good distribution throughout the house. The proper placing of the horns is important in talking motion pictures, because it is responsible for the illusion that the sound is coming directly from the mouth of the horn; that is, from the screen. If the horns are replaced by a loudspeaker which is of otherwise identical characteristics, but which radiates its sound over a wide angle, the sound has a tendency to appear to be coming from a point some distance back of the screen. The displacement results in a destruction of the illusion.

Both the Vitaphone and Movietone systems are now controlled by the Electrical Research Products Company, a subsidiary of the Western Electric Company.

The "flashing lamp" system of recording used in Movietone is the special invention of Theodore Case, who with the financial aid and encouragement of William Fox, of the Fox Film Corporation, brought to the industry a synchronization of sound photographed on the film itself. This method is said to be a great improvement over the earlier experiments in sound and talking pictures.

Electrical Research Products furnishes its theatre equipment in a sufficient variety of types and sizes to make it readily adaptable to all classes of theatres. It is not practicable to specify in detail what equipment is associated with each size of house, as acoustic conditions and other local factors make it necessary to consider each case separately.

Equipment may be obtained for either Vitaphone or Movietone or for both. Other attachments are obtainable as accessories to these systems. They include microphone

speakers, so that the management may address the audience; and public speaking address systems, which may be installed in the waiting halls for either the transmitting of music or the making of announcements.

The reader must already have drawn, from even these few pages, certain inferences—if, indeed, he has not been moved to exclamation. Although we know that we are dealing with a very new thing, the record reads more like that of a business long established. The contemporary partnership of science and commerce makes the creation of a new enterprise a matter of mere months. As skyscrapers spring from excavations while one is out of town, so a brand new business, overnight as it were, takes its place in the market, complete in organization, stock, promotion, and even advertising literature. Of course, the general phenomenon is no new one. That it applies here must come to the average man as an eye opener. Such is my secondary intention. Perhaps the surprise will grow as I proceed to my next subdivision, and the ones following that!

III. R. C. A.-Photophone

The R. C. A.-Photophone is a result of research and development in the laboratories of the General Electric Company in association with the Radio Corporation of America and the Western Electric and Manufacturing Company. It is a photographic recording and reproducing system invented by Dr. C. A. Hoxie of the General Electric Research Staff.

The Photophone marks the sound track with an irregular divisional line, which charts the sound and thus leaves part of the sound track transparent. A ray of light strikes the exposed portion of the sound track, reproducing the sound that is recorded on the film. The amount of light that passes through the sound track is regulated by the

width of the transparent part of the marked track. In the same manner is regulated the light which passes through the photograph film.

The R. C. A.-Photophone does not use a diaphragm. The sound comes through paper cones which act in a measure in place of a diaphragm. These are made in two sizes, twelve or sixteen inches in diameter and about six inches deep. They taper to an opening about the size of a silver dollar. At the outer circumference the horn is mounted on soft flexible kid leather, and on the inside on three fine silk threads. The horns are placed around the screen and masked from view. The number employed is determined by the size of the auditorium.

The Photophone method is to a great extent similar to that of Movietone. It has added to the projector a "sound head," which enables a narrow ray of light to be thrown on the sound track on the film. The light, after penetrating the sound track on the film, then falls on the sensitive photo-electric cell, which produces electrical currents corresponding to those of the original sound. An amplifier in the projection booth increases the power of the current thus formed, which is then transmitted by wire to the loudspeakers around the screen.

The component elements of a Photophone film are shown in Plate I. On the lower edge of this illustration is shown the type of sound record used by R. C. A.-Photophone. It will be seen that this is a narrow black band, the inner edge of which (that nearest to the picture) has a wavy outline. This last constitutes a faithful record of the air vibrations in the original music or speech. Its minute and complex contours are literally the permanent and accurate signature of the original sound waves. The combined picture and sound record shown demonstrates how picture and sound are bound together on every R. C. A.-Photophone film.

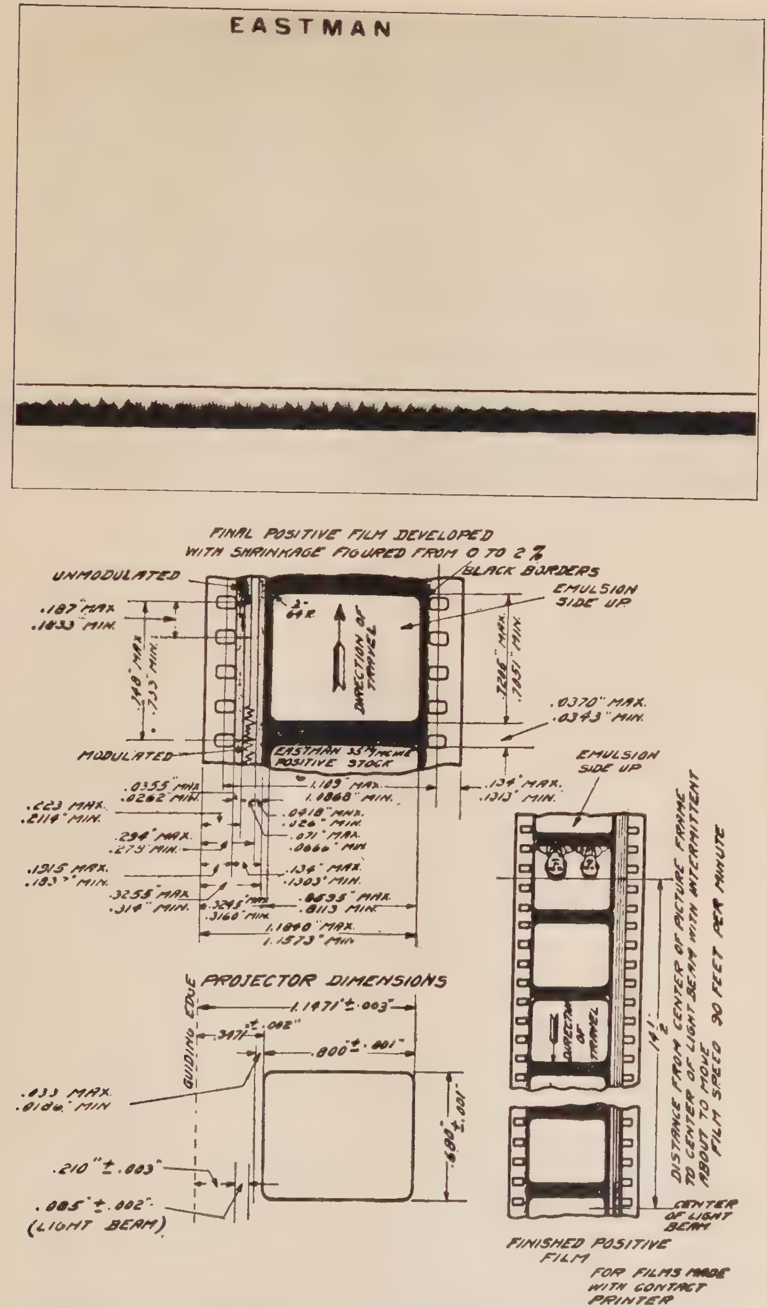

PLATE I. DIMENSIONAL CHARACTERISTICS OF R. C. A. PHOTOPHONE POSITIVE SOUND FILM

The exact timing of picture and sound is photographed and fixed regardless of any handling of the film or the projector and irrespective of any cutting or splicing of the film. A few frames of film can be lost, and the film can be spliced, without any noticeable effect on either the picture or the sound reproduction.

The four principal types of R. C. A.-Photophone equipment for theatres have the following type designations and will serve audiences of the following number of persons in any average auditorium or theatre:

Type	A up to	6,000 persons
	B up to	3,000 persons
	C up to	1,500 persons
	D up to	750 persons

The R. C. A. manufactures a projector which is equipped with a sound-reproducing head, which reproduces sound of all existing types of synchronized sound films. The film path is indicated by guide lines within the machine, which facilitate accurate threading.

The path of the sound light beam, which in the projector passes through the slit optical system and film sound track, falls on the photo-electric cell. In this cell the varying light gives rise to the corresponding electric currents which, after being greatly magnified by the amplifiers used in this system, operate the loudspeakers that reproduce the original sound on the stage. The action of reproducing the sound is instantaneous, and the sound-reproducing system is entirely automatic in operation.

The lights which are used to illuminate the sound track are provided in duplicate. Therefore, if one burns out during a performance, the touch of a lever brings a second, prefocussed lamp into position and lights it automatically without causing interruption in the performance. (It is in

such single incidental details that research discloses its patient, tireless wisdom.)

The initial amplifier is connected to the output of the photo-electric cell and amplifies this output electrically through a series of vacuum tubes until sufficient power is available to operate the final or power amplifier. The initial amplifier is always placed in the projection room in a convenient location, generally at a porthole, so that the projectionist at the amplifier control board may view the screen. The placing of the equipment will be different for each installation because of local conditions. A typical arrangement of equipment is shown in Plate II. In all sizes of R. C. A.-Photophone equipment larger than Type D, the initial amplifier is provided in duplicate. In all forms of the final power amplifier the equipment is open and accessible, permitting replacement of the vacuum tubes when necessary.

By the use of special circuits and grouping of unit parts the burning out of an individual tube or even the unusual development of a fault in an amplifier unit in general does not stop operation. It may merely modify either the quality or the volume of the sound to some extent (thereby directing the attention of the projectionist to the need for a tube replacement or other change in operation) without, however, totally interrupting the performance. R. C. A. Radiotrons are used in all Photophone equipment.

The final or power amplifier supplied in the R. C. A.-Photophone system may be placed in the projection room, or in a room closely adjacent to the projection room, or back stage, as may prove most convenient and desirable. In such cases, the R. C. A.-Photophone system permits the separate power amplifier to be installed wherever there is most room for it.

The power amplifier is connected to the loudspeakers which it actuates. An important unit in this system is the

auditorium public speaker invented by Dr. C. W. Hewlett, also of the General Electric Staff. These consist of electro-dynamic loudspeaker cone units combined in banks, or groups, as required.

Each loudspeaker group produces a wide, smooth fan of sound instead of a narrow beam. In addition, in larger theatres, several groups of R. C. A.-Photophone loud-speakers can be utilized, thereby to cover the entire theatre with a number of fans of sound.

A group of loudspeakers may be placed on each side of the screen. The groups may, at will, be mounted permanently on the side of the screen and "flyed" with the screen when it is lifted, leaving the stage clear for other performances or presentations.

Or, alternatively, the loudspeaker groups can be mounted on either ornamental, or inconspicuous, towers and wheeled onto the stage from the wings. The complete loudspeaker group is easily handled and practically no more difficult to move than a section of an ordinary stage set. The outside dimensions are 75 inches high, by 21 inches wide, by 21 inches deep, and the weight of a group is 250 pounds.

The ordinary wiring of the arc or incandescent lamp of the motion picture projector is identical with that used in any projector. Only the additional wiring incidental to the sound reproduction in the R. C. A.-Photophone system need be considered. The wiring of the sound-reproducing circuit consists of a continuous connection from the sound head of the projector to the initial amplifier in the projection booth, thence to the final amplifier, and thence to the loudspeaker groups on the stage. The wiring can readily be arranged in cable form, which can be run in existing theatres in almost every instance by a local electrician under the supervision of an R. C. A.-Photophone engineer.

A small amount of additional power and of battery wiring to the driving motor of the projector and its starter are required.

For reference there are presented in the following table essential data on the number of units and general performance of the several types of R. C. A.-Photophone reproducing outfits.

WATTS OUTPUT OF POWER AMPLIFIER	NUMBER OF LOUDSPEAKER CONES	MINIMUM SIZE OF AUDIENCE
80	16	6,000
40	12	3,000
20	8	1,500
10	4	750

TYPE	NUMBER OF PROJECTORS	NUMBER OF INITIAL AMPLIFIERS
A	2	2
B	2	2
C	2	2
D	2	1

A moderate and reasonable amount of supervision of the equipment to keep it in normally clean and efficient condition is all that is required of the projectionist. Change-over from one projector to another at the end of a reel, when the point corresponding to change-over is reached as indicated on the cue sheet, is taken care of by the turning of an accessible handle.

In addition to the equipment for projecting synchronized sound-picture film there is available a Photophone disk attachment for the projection of synchronized sound pictures which contain the sound effects on disk records. The disk attachment is a part of the projector. It is thus possi-

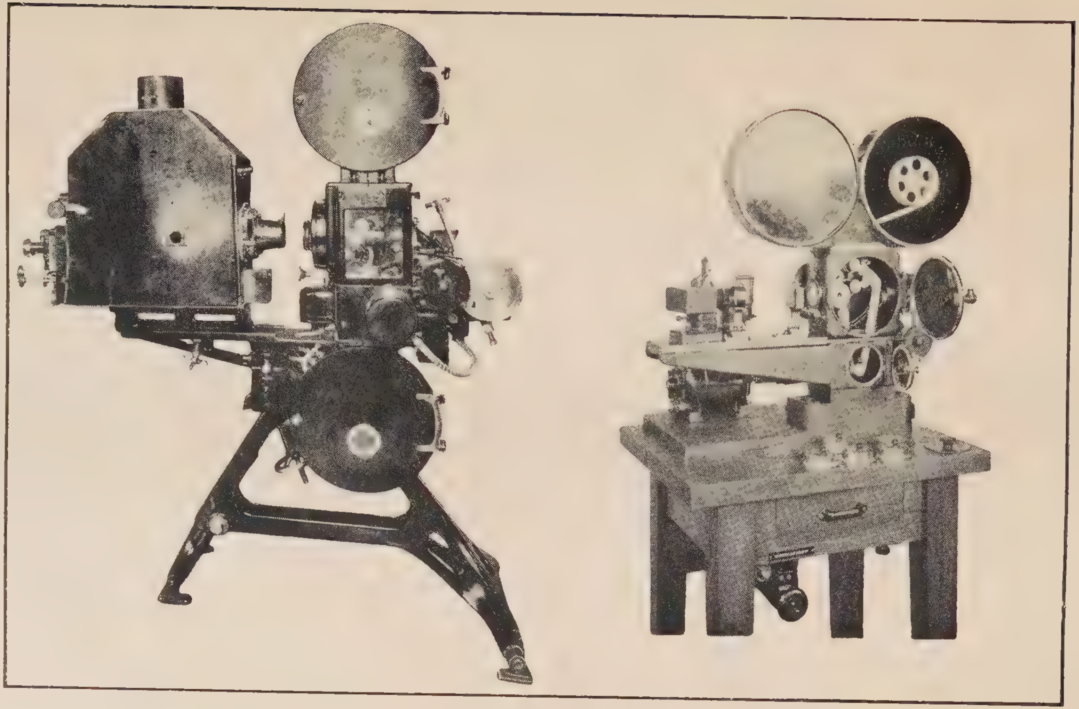

PLATE II. R. C. A. PHOTOPHONE PROJECTOR AND SOUND RECORDER

ble for the owner of Photophone projection equipment to take advantage of all synchronized sound pictures with disk attachments now being offered in the market. The music or sound effect contained on the disk is amplified through the regular Photophone amplifying equipment and projected into the house in the same manner as synchronized sound film.

Standard Photophone equipment has been designed to operate on 115 volts, direct current; on 220 volts, 3-phase alternating current; and on 110 volts, single-phase alternating current. Where direct current only is available as a source of power supply and also in the case of Classes A and B equipment, a four-unit motor generator will be required in addition to the standard equipment for projection purposes. The motor generator can be mounted either in the basement or in some part of the building where any noise made by it will not be heard in the auditorium. It can then be connected to the projection system by means of cables run through conduits. Equipment of Classes C and D does not require a motor generator provided 22 volts, 3-phase alternating current, and also 110 volts, single-phase alternating current, is available.

The motor generators referred to are used for the purpose of furnishing voltage for the large tubes in the amplifier section of the projection equipment and are not to be confused with the power supply for the arc for projecting the picture part of the film. As mentioned previously in this explanation, the light chamber and the lens now in use in any motion picture theatre are retained in service and are merely transferred to the new projectors which are furnished as a part of Photophone equipment.

R. C. A. also produces a small disk-type machine for use in theatres with a seating capacity up to 600 seats. It has been designed specifically and exclusively for this type of theatre. The same organization, in addition, makes four

types of equipment. They are for theatres with 750, 1,500, 3,000, and 6,000 seating capacity. The information I have given in this section relates to Type A. The equipment for Types B, C, and D machines is as follows:

Type B Photophone

1. Two combination picture and sound projectors complete, less lens and projection lamps.
2. One amplifier complete with switching panel.
3. Two storage batteries, Exide, type 3-XCR-19.
4. One four-unit motor-generator set.
5. One motor-starting switch (remote control).
6. One generator fuse panel complete.
7. Twelve loudspeakers complete—six with 45° mounting, six with 15° mounting.
8. One monitoring loudspeaker of electro-dynamic type.
9. One visual signalling system with lamps.
10. Radiotrons as follows: (a) Two UX-210; (b) one UX-841; (c) eight UV-845.
11. Two photo-electric cells, type PJ-15; four photocell lamps (prefocussed).
12. Instruction book.

Type C Photophone

1. Two combination picture and sound projectors complete, less lens and projection lamps.
2. Input control panel with visual signalling system, including lamps and fader extension.
3. Amplifier rack, including (a) voltage amplifier control panel; (b) power amplifier control panel; (c) two voltage amplifiers; (d) two power amplifiers; (e) two battery shelves.
4. Batteries as follows: Six heavy duty 45-volt B batteries; five general duty 45-volt B batteries; four $4\frac{1}{2}$-

volt or two 9-volt C batteries; four Exide type MVJ-131-192 ampere hour 6-volt batteries.

5. Battery charging equipment with switch panels.
6. Eight loudspeakers complete—four with 45° mounting, four with 15° mounting.
7. One monitoring loudspeaker, RCA 100-A (special).
8. Radiotrons as follows: Twelve UX-210; four UX-250; four UX-281.
9. Two photo-electric cells, type PJ-15; four photocell lamps (prefocussed).
10. One M. G. set complete with starter, fuses, and switch panels.
11. Instruction book.

NOTE: *Item Number 10 is for D. C. equipment only.*

Type D Photophone

1. Two combination picture and sound projectors, complete, less lens and projection lamps.
2. Input control panel with visual signalling system, including lamps and fader extension.
3. Amplifier rack, including: (a) Voltage amplifier control panel; (b) power amplifier control panel; (c) one voltage amplifier; (d) one power amplifier; (e) one battery shelf.
4. Batteries as follows: Three 45-volt heavy duty B batteries; five 45-volt general duty B batteries; two 4½-volt or one 9-volt C batteries; two Exide type MVJ-13-192 ampere hour 6-volt batteries.
5. Battery charging equipment with switch panels.
6. Four loudspeakers complete—two with 45° mounting, two with 15° mounting.
7. One monitoring loudspeaker, RCA 100-A (special).
8. Radiotrons as follows: Six UX-210; two UX-281; two UX-250.
9. Two photo-electric cells, type PJ-15; four photocell lamps (prefocussed).

10. One M. G. set complete with starter, fuses, and switch panels.
11. Instruction book.

NOTE: *Item Number 10 is for D. C. equipment only.*

The relative importance, in the field, of the three organizations I have discussed, in comparison with the two that follow, I leave to the judgment of the reader and the verdict of time. Suffice it for my purposes, at this juncture, merely to state that, having dealt with two organizations thus in full, I can treat the others with a measure of economy and facilitate a more rapid transition to other matters which this volume must include to cover my whole theme.

IV. Phonofilm

Phonofilm is manufactured by the DeForest Phonofilm Corporation and reproduces auditory impressions through a sound track. The synchronizing attachment embraces a small incandescent lamp and a highly sensitive photoelectric cell. As the film passes between these fixtures, light falling upon the cell regulates its electrical resistance. This controls the amount of telephonic current being supplied by a connecting battery, which is then amplified through a series of audion amplifiers.

What we have, then, is a spiral sound-on-film record, using the DeForest Phonofilm amplification. A separate film strip runs through the attachment, comprising a spiral record of sound.

The picture and the sound are printed about fifteen inches apart, with the sound above the picture, as seen in the projector. Sound is recorded through an optically imaged slit. Conversion from light pulsations to electrical current is accomplished by means of a gas-filled photo-

electric cell. The reproducing light is obtained from a 50-watt, concentrated-filament Mazda C lamp, located in the projector. This light, passing through the film on which the blackened area is proportional to the sound, effects pulsations of current in the photo-electric cell. The alternating component of this current is then carried to the amplifier. The power is amplified and controlled to the value necessary to operate the loudspeakers, the size of the amplifier depending upon the service required.

Two types of Phonofilm reproducers have been developed. One has an attachment for a Simplex projector inserted between the upper magazine and the projector head. A constant speed motor is substituted for the variable speed mechanism of the standard projector. The other is a complete projector in which sound and picture mechanisms are contained within a single housing.

Another additional piece of equipment which is part of the R. C. A.-Photophone system is a double turntable electric pick-up phonograph by means of which nonsynchronized music can be played during a performance, as an overture between performances, or at any other time. Music from nonsynchronized phonograph records is also amplified by the regular Photophone amplifying system and projected out into the house from the loudspeakers mounted on the stage. This phonograph also has the means whereby an announcing microphone can be cut into the circuit by the throw of the switch by means of which announcements can be made to the audience.

Obviously, the inventor's specialized connection with radio and radio tubes is his point of contact with the industry we are discussing. That he has stamped his name on an added device in a fresh domain is indicative not only of his own resilience but of the growing complex relations, not only in kindred businesses, but in the fields of scientific speculation underlying them.

V. Bristolphone

The Bristolphone is a phonographic type device with the sound recorded on the disk. It is produced by the William H. Bristol Manufacturing Company. The apparatus consists of a turntable connected to the projector. It is claimed for this machine that the sound can be started and stopped without getting out of synchronization with the motion picture, by simply turning a device attached to the machine, which will immediately resynchronize. This is an advantage if the film should break and throw the sound out of synchronization. The amplifying device consists of an amplifying unit similar to that used at large radio stations, with a horn set back of the screen. The apparatus uses a double turntable device, which can be hooked up to the same amplifying unit, on which records can be played—in sufficient volume to fill an average-sized theatre.

This synchronizing system consists of two special synchronizers, one of which generates the electrical energy in its magnetic field to feed the field of the other. The armatures of both synchronizers are energized from an alternating current line. When the armature of one of the synchronizers is turned by an outside source of power, the armature of the other synchronizer turns the same amount and at the same speed, transmitting power electrically from one synchronizer to the other, with synchronism at any speed. These synchronizers are attached to the projector by a five-wire cable. A motor beneath the turntable drives the turntable through the worm and gear and also drives the armature of the turntable synchronizer, which in turn drives the armature of the projector synchronizer, so that the projector is furnished with power for its operation. Synchronization of the film with the record on the turntable is thus maintained.

From the description and illustration it may be seen that

the turntable unit consists simply of a driving motor, a governor, a worm and gear, and a synchronizer. The other synchronizer is attached to a projection machine on a suitable bracket, the two synchronizers being connected only by the five-wire cable.

During the past few years there have been many new companies formed to manufacture or service sound equipment. All of them make either the phonograph or disk type. In general, they consist of what might be termed a double phonograph, consisting of two disk turntables. Amplification is obtained in some instances through the use of radio tubes; and phonograph recording records are used in the operation of such apparatus.

Managements which contemplate the installation of sound equipment should make themselves thoroughly familiar with the reproduction system they are considering. It is very important that those who install such equipment shall be assured of a dependable source of supply of pictures to fit the mechanism, at least until such time as interchangeability among the various systems becomes an assured fact. I am the last man to discourage enterprise; but blind clutching in the air is not what I would call enterprise. The whole of our discussion here is bound up with science. There is a science of commercial administration, too. It is based on a few common-sense principles. One of them, I should say, may be put in this simple, homely imperative: Don't try to meet the demand without studying the supply!

CHAPTER IV

FUNCTIONS OF VARIOUS APPARATUS

I. The Man in the Booth

The development of sound apparatus, because of the space necessary for the proper installation of the various standard devices, has made necessary, in many instances, the redesigning and reconstruction of projection rooms. Architects are now planning projection booths to meet the new requirements. In existing quarters it has become necessary to move walls to conform with the emergencies and with the municipal regulations. The latter presented a big problem, for alteration and installation of equipment in most instances has had to be accomplished while the theatre was in use.

The proper education of man power to handle the new machinery presented another task to management. Even for the most expert projectionists the handling of new and delicate machinery requires technical knowledge and considerable personal readjustment. The proper schooling of projectionists, wherever equipment is installed, is a matter of prime importance; but on the whole this situation has been dealt with quite successfully.

Sound devices have been developed to a stage of relative perfection and can be operated by a skilled projectionist after a relatively short period of instruction and practice. Further simplification is making the issue less and less troublesome. There is no reason why the average projectionist who is willing to devote the effort necessary to the

study of the fundamentals of the technique involved should not within a reasonably short time become proficient as the operator of a machine to project pictures and sound.

Let me make the interpolation, in passing, that, next to the sound-reproducing apparatus itself, one of the most important adjuncts to good results is the use of a screen that permits transmission of sound without sacrificing proper screen reflection. There are various screens being manufactured at this time that are designed to meet the situation. Yet even with the best screens now in use there is some loss of reflection power where the horns are placed behind the screen. This presents a problem that will in all likelihood be solved before long, for all technicians realize that the proper reflection of light is a matter of utmost importance. In the meantime the mechanic should give the matter his best thought.

It is furthermore desirable in the design of the projection room to eliminate to the fullest extent all vibration or foreign sounds which might make themselves felt because of the delicate reproducing apparatus.

An aperture mask is used when making the change from regular film to Movietone film. The necessity arises because the sound track of Movietone reduces the width of the picture, and cannot of course be permitted to appear on the screen. A compensating change in the lens is required, if it is desired that the masked picture be the same size on the screen as the silent picture.

Thus the experience and skill of projectionists must contribute a great deal to the proper manipulation and result. While in the beginning it was necessary to sacrifice visual imagery for auditory, at the present time the careful mechanician has at his command equipment that makes the deficiency unnecessary.

Improved methods of making change-overs from one machine to another have likewise been evolved, and now

such transitions are made gradually and without detection. It is extremely important, of course, that there be no interruption of the running of a story from one reel to another, so as to maintain the illusion of realism. In some theatres the change-over is made by stopping one projector and starting the other, both by hand; but in the best equipped projection rooms mechanical transferrals are used. The change-over is then made on a fade-out, or at the end of a scene. In projecting sound pictures, moreover, experience indicates that it is much better practice to make change-overs on titles, to avoid either repeating or omitting any of the scenes. The title provides a direct arc, and the change-over is made from one projector to another on the same wording. It requires about five seconds for the motor of a projector to attain the proper speed. The title change-over permits the projectionist to transfer at the precise moment of maximum advantage. If the change-over were made before the projector has attained the proper speed (a standard of 90 feet per minute has been fixed for sound pictures) the speed of the sound-reproducing device would be too low. There would result a loss of tonal value and an effect similar to that which one gets from a phonograph which has not attained its appropriate tempo.

The advent of sound has, therefore, had a very beneficial effect in developing projectionists of a higher type. These men now realize that there is a technique in the work, and that there is room only for those who take the new art seriously. Every mechanic who has had experience with any of the standard new devices understands the necessity for increasingly careful, accurate work. In order to comprehend the proper operation of sound-reproducing apparatus it is important that the operator have at least an elementary understanding of electricity. The projection room is the heart of the theatre. It is the quality of projection

and sound reproduction that will make the operation of such apparatus either successful or not.

The projection room, one can see, now contains apparatus that is both complicated and delicate; and because of changed circumstances, the projectionist has the important responsibility of handling the apparatus with intelligence. In the case of Movietone, for example, the photo-electric impulse is so delicate that it must be amplified almost one hundred thousand times before it reaches the loud-speakers. The man who is in control of apparatus such as this must be more than a mere mechanic—he should be a student of his new art. It calls for a study of the various auspices that guarantee perfect sound reproduction and embraces an inquiry into the laws of acoustics, as well as a knowledge of the parts of the apparatus itself. The projectionist should have an understanding of the principles of amplification and familiarize himself, not only with operation, but with the underlying laws upon which it depends. He should know what part each unit plays in producing a competent result. Much of the future development of sound equipment will come from the projection room, from those who realize the opportunities that lie before them. The projectionist can do the industry a great service in seeing to it that sound equipment is used to its best advantage, so that the public may judge the future of the medium in the proper light.

Again, sound has brought the necessity of a more accurate projection than in the past, because dialogue and enunciation must be sufficiently clear to be readily understood. Otherwise there will be complaint. It can readily be seen that the projectionist becomes one of the most important factors in the success of the sound motion picture theatre, and because of this his work must be carried on seriously and he must assume the responsibility that goes with the job.

II. Installation

It is the purpose of this chapter to deal with the equipment and operation of the standard sound devices. Perhaps the reader will get a clearer picture of the problem if we follow an installation through from its inception to its completion. In this manner the scope of the work will make familiar the many details involved. For illustration, the Western Electric Sound Projection System is selected here. This system is furnished by the Electrical Research Products Incorporated, who supervise the installation, instruct the local personnel in the details of operation, and provide service inspection during operation. Figure 3 shows general installation layout for sound motion pictures, Western Electric System.

Of prime importance in preparing a theatre for sound projection is the initial engineering survey, because it determines the type of system that is to be installed as well as any requirements for special treatment. In this connection it may be pointed out that each theatre presents a problem in itself and must be considered as such. The survey engineer first studies the acoustical facilities and requirements. From these he gathers pertinent information on which his recommendations are based. His survey is studied by a special staff at the laboratory, who organize the final conclusions.

In the projection room the engineer becomes familiar with the power supply, as to voltage frequency (if A. C.) and capacity, so that he can measure properly the load that is to be used. Where existing projection machines are used, the type, the condition, and the angle of projection must be carefully noted. The question of proper spacing between machines, to permit the proper attachment of sound apparatus, is an important factor, if operation is to be safe and competent. Room must be found for the amplifying

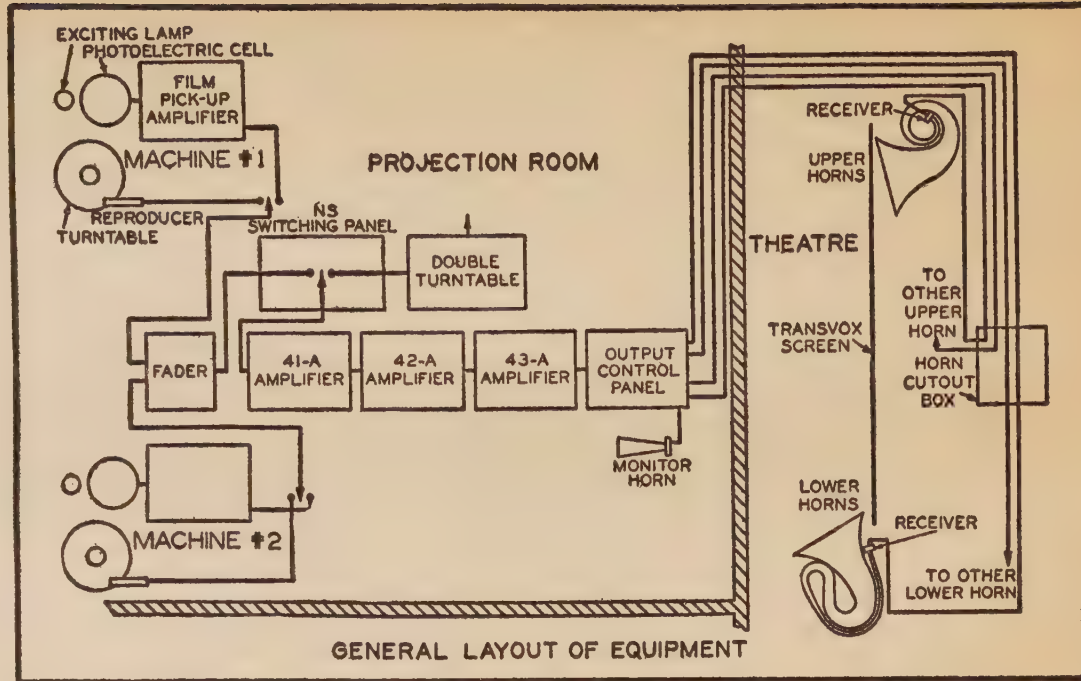

FIG. 3. GENERAL INSTALLATION LAYOUT FOR WESTERN ELECTRIC SYSTEM FOR SOUND MOTION PICTURES

equipment and the various controls. It is sometimes necessary, particularly in older theatres, to rearrange and enlarge the projection room. Then space must be found in a separately enclosed room to house the storage batteries.

The auditorium itself requires specific study, because upon its characteristics is based the size of the installation. The systems are not standard but are built to meet conditions imposed by theatres, from the largest to the smallest, and careful selection is necessary in order to insure sufficient sound volume. In the case of an existing theatre, blueprints of the auditorium are not always available. It frequently becomes necessary, therefore, for the engineer to take dimensions himself, since the cubical volume is an important factor. Seating capacity and distribution of seats also exert their influence, and the general acoustics of the house must be considered. The proper degree of reverberation may be calculated, bearing in mind the absorptive effect of the audience. Echoes of interference of any description, such as internal or external disturbing noises, naturally must have an effect upon the ultimate installations. The ultimate and specific study of acoustic properties is made when the system is finally tested, but engineers may observe or anticipate certain general effects during the survey process.

The size and the layout of the stage must receive consideration with particular reference to the location of the horns and of the special screen to be used with the system. When a theatre shows motion pictures alone the horns may be permanently located on a suitable structure. If, however, vaudeville or stage presentations are included, the problem requires greater study. In such cases the horns may be placed on movable towers or on an elevator lift that disappears into the floor of the stage, or they may be flown from battens. In some instances a specially contrived

trap may draw the horns offstage. If they are counterbalanced by weights they may easily be drawn into position. Another important matter that requires attention when movable horn equipment is being installed is the proper masking of stray sound, which might otherwise go into the space above the stage.

Information sufficient to permit a knowledge of the conduit runs for the complete installation is also obtained at the time of the survey. All the data collected is augmented by sketches prepared by the engineers, in conjunction with the blueprints of the building (when they are available), thus providing the home office survey staff with a complete picture of the requirements of the theatre. On the basis of the facts thus collated the type of sound projector system is selected, and the dates of shipment of equipment and installations are placed on schedule. Where architectural changes in the theatre are necessary, the local management is notified in the anticipation that necessary alterations may be completed prior to the actual introduction of the apparatus.

At the outset of an installation it is important for the engineer to establish satisfactory personal contacts with the local people and organizations that will be concerned in the work. This coöperation is necessary so that the work may proceed smoothly and be completed without delay, in time for the opening date that has been fixed. In fixing the date for installation, time for testing and rehearsals must be allowed. The engineer first meets the house manager and subsequently the projectionists, the house electrician, and stage hands, and familiarizes himself with the house conditions as to policy, operating hours, labour agreements, etc., so that he can determine the best time for the actual installation. It is necessary to find a competent electrical contractor—one, if possible, who already has knowledge of the theatre.

The installation proceeds in accordance with a carefully laid out plan. First the driving equipment for the motion picture projector is installed. Although the projection mechanism itself remains practically intact its driving motor is replaced by one with an electrically regulated speed control. A film speed of 90 feet per minute is necessary for sound-picture work, but variable speeds may be obtained, if desired, for silent film. Since the motors require four or five seconds to pick up speed it is essential that the projectionist become accustomed to this feature and others like it, so that he may be able to give full attention to the handling of film or disk records when the time for operation arrives.

The battery equipment is installed next, together with the related switching panel and charging apparatus. This permits an investigation of the condition of the batteries and gives ample time for charging them, if necessary. It also gives projectionists an opportunity to study this portion of the apparatus at their leisure and to have explained to them proper schedules of charging. Should a motor generator be required it is set up at this time.

The amplifiers and allied equipment are placed upon the relay racks, and the fader and its auxiliary boxes are mounted at the front of the projection room wall. The position of the monitor horn is carefully selected so that the operating personnel will at all times be able to hear clearly, for it is by following the programme through this horn that fader change-overs are made.

The conduit installation keeps pace while the apparatus is being placed in position. The storage batteries and the alternating current supply are now connected with the amplifying equipment, all of which is carefully checked and tested. The fader can be used with either the film or the disk reproducers associated with the production machines. A film disk transfer switch is included in the reproducing

machine now in use, and permits either the film or the disk producers to be used at will, simply by pressing the proper push button. A signal light gives adequate notice of the circuit which is set up. Interconnections between physically disassociated groups of equipment are made through a junction box located in a projection room. This method not only facilitates installation but provides a ready means for circuit checking and trouble finding.

While equipment and installation methods are constantly being simplified it may be noted that a rather marked advance in this direction has been made during the past few months. In the beginning, the driving motor and disk turntable were mounted on separate mounting pedestals. The film reproducer and associated amplifier are still supplied as separate units to be assembled as an appendage, and the film disk transfer panel is an apparatus separately mounted on the wall. At present, however, these individual pieces are joined into a single united whole. A pedestal is furnished with sufficient space for placing the driving motor and mounting the disk turntable. The film reproducer and amplifier form a definite part of the pedestal. A film disk transfer switch is associated with each unit that permits the projectionist to make his machines ready for the succeeding selection to prepare completely for the change-over. Equalizers that are necessary are included in the pedestal on special wiring, so that switching of such units is eliminated. A mechanical brake provides ready halting of the projector.

The installation engineer next turns his attention to the stage. The horns are placed in the mountings which have been prepared. They are located in positions which, experience has taught the engineer, may be roughly correct for the particular type of house. When horn installations have to be moved during performances it is decidedly advantageous to place the horns on movable towers or on an

elevator which sinks into a trap on the stage. The latter method is preferable, since then the horns are automatically set in their proper position behind the screen. After the loud-speaking receivers are attached to the horns and connected in circuit a cursory test follows to check any possible errors. This is the first opportunity to produce sound through the complete system. Imperfections are immediately corrected. Comparative tests are then made between the sound reproducers on the projectors equipped, so that variations in tone can be compensated for. The receivers and horns are heard separately, and afterward in unison, to check poling. Receivers incorrectly poled give a most unpleasant effect of pressure in the ears of the listener if he is at the junction of their sound paths.

Before proceeding further it is desirable to have the screen used with the sound system in place—an obvious requisite of the talking picture, so that the sound shall seem to emanate directly from the scene of action on the screen. If the sound source is placed immediately behind the area of action in the picture the illusion is improved. To present the best illusion a special semi-porous screen is used. It permits sound from the horns located directly behind it to pass through readily. With the type of screen in use at present a small percentage of light is lost from the picture, but improvements are being made in screen equipment from time to time. With the screens in place and the horns set temporarily, acoustic tests are now made, and the system is finally checked.

Acoustic conditions of theatres are responsible for the obtaining of widely different results. Some houses give a mellow effect; others make reproduced sounds appear metallic. The shape of the interior has less effect in general than has the nature of the surface of the walls, the ceiling, and the floor. If these surfaces are hard and smooth like ordinary plaster, concrete, polished wood, or glass,

they will reflect most of the sound striking them. Different frequencies, also, may be reflected in varying proportion. When surfaces are made of soft, thick materials such as heavy drapes, carpets, upholstery, or where the audience covers a relatively large space, a good portion of the sound is absorbed. Pilasters, mouldings, cornices, and such broken surfaces disperse sound waves and tend to damp them out quickly.

The hard or reverberant type of theatre is especially annoying for speech selections, since the duration of audibility is so great that one sound remains to overlap the sound succeeding it. This gives an effect of poor articulation. For music reproductions, however, a reasonable amount of reverberation is acceptable, for it contributes to the impression of fullness and roundness. Another uncertain factor, which further complicates the situation, is the varying size of the audience. Theatres which may be entirely too reverberant when empty will sometimes give pleasing results when filled. Unfortunately, it is not possible to have a completely filled house at every performance. It will therefore be seen that, at best, a compromise must be tolerated.

Reverberation depends upon the rate of decay of sound and is measured by its inverse, the duration of audibility of a sound of known initial intensity. The introduction of highly absorbent material into a room will have greater absorptive effect on the higher frequencies. If the thickness of the material is increased considerably, the absorption of the lower tones will be increased, while that of the higher frequencies will remain practically intact. Very thin fabrics, such as cheesecloth or bunting, absorb only extremely high frequencies.

A considerably damped auditorium will cause sound to appear to lack brilliance and definition and will produce an effect of deadness, which in extreme cases may be almost

depressing. Greater electrical power will be required to fill the house with comfortable sound volume, but the effect of the presence of the audience will be relatively slighter than it is in a reverberant house.

Echoes, generally speaking, are due to too great differences in the lengths of the sound paths of direct and reflected sound which reach an auditor in a given position in a room. An interval of about $\frac{1}{16}$ second is noticeable. Proper location of the source of sound, or the placing of drapery material over the offending reflecting surface, will ordinarily correct echo.

Interference is usually produced by the crossing of many trains of sound waves reflected from various parts of the room. It results in distortion and is overcome by proper placing of absorbent matter.

Resonance results from a surface consisting of some thin, hard material which is free to vibrate as a diaphragm at its own natural frequency. Thus, sound may be reinforced. Distortion will probably result, since only that portion of complex sound whose frequency is near the natural period of the resonator is affected.

Fortified with a knowledge of these general acoustic considerations, and bearing in mind the three prime requisites to good hearing, i. e., that sound should be sufficiently but not unnaturally loud for all auditors, that successive sounds be clear and distinct, and that the components of complex sound should retain their relative intensities, the engineer makes his acoustic adjustments. He usually tests first for sound distribution and arranges his horns so that, in so far as is possible, all portions of the house receive a like amount. Good distribution can normally be obtained by proper flaring and tilting of the horns. Any acoustic peculiarities are then investigated and, if possible, corrected. Slight variation in the location of the horns may result in quite marked differences in the results

obtained. Hence this test may involve many hours of labour. It may even be necessary to convince the management that acoustic treatment is essential if good reproduction is to be obtained.

One standard practice which is followed in all cases requires that the horns, and the back of the screen not occupied by the horns, be completely enveloped by absorbent drapes. If the sheet is set back from the proscenium arch it is also customary to hang drapes in shadow-box effect. This treatment eliminates back-stage reflections of sound.

After the horn locations have been definitely fixed and the equipment has been given a final checking the engineer proceeds to calibrate the theatre. He has available several test records embracing a rather wide variety in the character of selection to cover the different types of entertainment which are likely to be shown in the theatre. By playing these records and adjusting the main volume control potentiometer on the amplifying equipment until the proper effects are obtained with the fader at average value, it should be possible to obtain good results in all subsequent operation by using normal fader volumes for any succeeding selections. In other words, this potentiometer setting, which thereafter remains fixed, compensates for the varying sizes of theatres, and permits like effects of reproduction to be obtained universally. In addition, different types of selection require that varying degrees of volume be fed to the different horns. From the test records the engineer is able definitely to determine what these volumes should be and so establish the horn setting values which are normally required. When the potentiometer values and horn settings are determined, the theatre is considered calibrated. Such routine tends to standardize sound reproduction, in so far as that is possible, in theatres using sound-projector systems.

While the installation has been progressing the operating personnel have been instructed in regard to the functioning of the equipment and the proper method of handling it. At the outset each man has been given a copy of a complete operating instruction bulletin as his personal property for study and reference. By the time the installation is completed, and as a result of the running of the equipment during the acoustic tests, the projectionist should be able to start up and adjust the amplifying equipment in preparation to running the show. He should be able to thread the projector with film through the sound-gate compartment with surety, and to adjust his sound-reproducer lamp (for film reproduction). For disk reproduction he should know how to place the starting mark of the film in its aperture and fix the needle of the reproducer on the starting mark of the record.

The rehearsal of the opening programme is an important event. It not only enables the projectionists to demonstrate their ability in handling the equipment under real operating conditions, but also gives them experience in actual change-overs of picture and fader. The engineer can acquaint the manager with the technique of running the show to obtain best results. While the physical operation of the apparatus is the responsibility of the projectionist, the manager in the last analysis is responsible for the effects in the theatre as a whole. Either he, or someone assigned to the work, should be present in the audience during the showing of sound pictures. Even though rehearsals of programmes have indicated proper operating points of the various selections, certain conditions arise which may require changes in volume. The manager, now acting as observer and auditor, is able to be in touch with the projection room, and to transmit his wishes, by means of a buzzer signal system and telephone circuit, which are provided. It is, of course, essential that this observer be

not only entirely familiar with the results which the system may be expected to give, but also informed as to how to originate requests for obtaining the changes which he may wish. Upon the ability and conscientious efforts of this observer depends in a large measure the success of the sound-picture programmes.

The installation personnel remain at the theatre until it is evident that the equipment can be handled in a commendable manner. When this stage has been reached the installation is transferred to the service organization of the Electrical Research Products Incorporated.

III. Service and Maintenance

The function of the Service Department is implied in its name. The service engineer in whose district the theatre is located is available for emergency calls at all times. In addition he visits the theatre periodically to check the equipment and recommend what minor adjustments may be necessary. He listens to the selections on the programme and makes any suggestion to the manager which may occur to him. In this manner all of the theatre systems are kept under frequent engineering supervision in an earnest endeavour to maintain the class of service which they may be expected to give.

In earlier experiments horns were placed in the pit, with the idea that they would simulate the actual sound from an orchestra. Similarly, speakers were installed at the side of the screen and were found to create an imperfect illusion. Only by placing the speakers near the source of the sound can a true illusion be obtained. It has been found, furthermore, that the illusion may be more complete when the horns are placed behind a porous screen. The sound should be controlled by someone in the audience, since the projectionist is not able to get more than

a vague idea of the effect in the theatre. Management must be capable of judging the desired amount of volume necessary for the film shown.

Screen surfaces deteriorate very rapidly. Hence, whenever it is possible, the screens should be changed every ninety days. They collect dust and dirt and consequently lose reflecting power.

Disks may warp if they are laid on an uneven surface. Therefore, great care must be exercised in setting them down even temporarily. They should not be lifted or carried in stacks, nor be placed on any surface which does not equal in width the circumference of the disk itself. Overlapping the edge of a flat table or shelf may sometimes cause bending. The long experience of the Victor Talking Machine Company in packing disks for shipment has enabled them largely to overcome warping in transit. Should warping exist, however, the difficulty may be overcome by placing disks temporarily on a true flat surface. Disks are also affected by dampness as well as by heat, and therefore they must not be placed close to a radiator. They should rather be kept in a place that is both dry and reasonably cool.

Care must be taken in handling the disks to obviate scratching.

The advent of sound motion pictures in the theatre has elevated the projectionist to a position of greater importance by making him a supervisor of maintenance. It behooves projectionists to realize the opportunity that is theirs in making a careful study of the entire subject of sound, particularly as it pertains to projection, in order that they may take the fullest advantage of their opportunities. It is eminently important that every projectionist understand clearly the equipment that is placed in his charge, if he is to give the best that is in him to his work. A good mechanic should understand how to make temporary

repairs or adjustments, because problems are likely to arise before engineers and service men may be reached. In order to understand and develop an intimate knowledge of the apparatus that is placed in his care it is imperative that the projectionist have at least an elementary understanding of electricity. To those who are familiar with the standard apparatus it is needless to indicate that the mechanism is very delicate and must be handled with care. It is as much an instrument as a machine. The man who handles it must therefore be more than a labourer. He must be part artist and part engineer.

With present recording methods, for example, in order to secure the best sound-projection results, it is necessary to vary the volume according to the record. It becomes important, therefore, that projectionists rehearse the picture that is to be projected in order to establish the proper sound value for the theatre. Someone in responsibility should watch the performance to insure proper tone value through the varying attendance at the theatre. Such a person should be familiar with the A, B, and C volume set-up as established by the installation engineers, so that he may understand the scope and possibility of the volume control.

Distributors furnish a cue sheet, which indicates certain volume changes, and projectionists should follow this cue sheet for the best results. Observation should be made of the sound variations indicated on the cue sheet. This, together with the rehearsal of the picture in the theatre proper, should guide the judgment of the person who is held responsible for proper tone value.

It is likewise extremely important, if the best results are to be obtained, that the manager of a theatre attend the first performance on the opening day of each new programme. After the first performance changes should be made when they may improve the results. The entire success of sound pictures and the satisfaction of the public

can be insured only if all objections are eliminated. Management cannot, therefore, expend too much effort to guarantee a performance of quality.

In the management of the Fox-West Coast Theatres, the operation of projection of sound equipment has been standardized. The following details have proved practical and conducive to the best results. These instructions are intended to give a complete operation in the handling of sound projection from the beginning to the first changeover and, of course, are to be repeated with each succeeding reel:

Fox Movietone and Vitaphone Installations

1. Place the film in the upper magazine, emulsion side toward light.
2. Be certain that the main blade of the shutter is *up* in position and that the intermittent has just completed one full movement.
3. Thread the mechanism in the usual manner.
4. Be sure that the STARTING MARK on the film is *in frame* at the aperture.
5. Make the loop between the intermittent and the lower sprocket, so that the film rests against the index finger held across the opening of the lower film shield. It is important that this loop be of proper length so that the film between aperture and the sound gate will measure $14\frac{1}{2}$ inches.
6. Thread the film to the left lower idler under the lower sprocket. Draw tight to the sound gate sprocket. Then raise the film two holes before closing the idlers.
7. For film-recorded sound pictures, it is important that film be perfectly centred on the slit in the sound gate and that the gate be tightly closed.
8. Select the disk corresponding to the number of the film.
9. Place the disk on the turntable and clean it with the especially provided record cleaner.

10. Select a perfect needle. Insert it in the reproducer securely and place it exactly on the starting mark indicated on the disk.
11. Check all loops, idlers, and sprockets. Make sure that the number on the disk and the film correspond. Be certain that the starting mark on the film is in perfect frame and that the needle is fastened securely, tracks correctly, and is placed exactly on the starting mark indicated on the disk.
12. Turn down the record the required number of full turns indicated on the cue sheet, making sure that the film and the needle are tracking properly during this operation.
13. Strike the arc and start the motor on the cue. When all is up to speed, raise the dowser and on the proper cue bring the fader up to the required mark as per cue sheet.
14. Give the second projection the cue to strike the arc on the second machine, and stand by for change-over.
15. Stand by for the cue indicating the end of the record. Make the change-over on the fader to the second projector at the cue.

Experience has shown that the average record may be run from eighteen to twenty-two times with fairly good results. Occasionally, when there is a defect in manufacture, or because of excessive needle scratching, a record will last only a few runs. Talking records generally do not last as long as music records. It is advisable that three records of each subject be on hand in the projection room for pictures that are played for a full week. Caution should be taken not to permit the supply to diminish to one record and thus make possible an insurmountable emergency on account of any breaking or scratching of this last disk.

In the case of breakage and repairs it is possible to proceed without a stop to re-wind if the break occurs below

the aperture, but if the break is above the aperture it is necessary to stop the machine. It is therefore important to take every precaution in advance to prevent breaks. In patching film that is played with records, it is essential to replace the film cut out with the exact number of frames of blank film that have been eliminated, if correct synchronization is to be maintained. A supply of blank film and cement must naturally be on hand at all times. Even as little as a few inches of eliminated film will cause non-synchronization. Synchronized film is numbered on the edge of each sixteenth frame. Therefore it is easy to calculate the exact number of frames that are to be patched. Such film taken from the print, in order to make the patch, should be placed in an envelope. One should also mark the number of the reel from which it has been taken, and return it, together with the print, to the exchange at the close of the engagement.

Inspection of all film and records must be made in advance in order to insure their perfect condition in time for the performance. Used or broken records must be returned to the distributor.

Sound pictures cannot be cut or speeded up as an ordinary operation, but must be maintained at a speed of ninety feet per minute.

In case of emergency, projectionists should endeavour to locate the trouble with the aid of the instruction booklet that is furnished. In addition, the nearest service station must be informed immediately. When a service station is out of town, it is best to call the representative on the long distance telephone, and to give him a report of the difficulty.

To avoid the many difficulties encountered in sound projection because of faulty needles, projectionists should examine each needle individually before using. All needles not of standard thickness, or with points so blunted that

they do not fit the grooves of the disk records properly, should be eliminated. Needles with the slightest imperfection should be rejected. A new needle should be used with each change of record. It is very important that the greatest care and accuracy be employed in the selection and examination of needles, because any fault in this respect will give poor reproduction of sound, will also create surface noises, and will in other ways detract from the excellence of the performance.

With the cold weather come resultant low temperatures. It is therefore important to have the proper degree in the projection room. Here is an instance: There are two points on the Western Electric sound projector equipment in which lubrication is accomplished by means of an oil "bath"; namely, the 703A and 706A drives. Low temperature in the projection room causes the oil at this point to congeal. The resultant friction in turn causes the machine to start slowly and also tends to place an undue strain on the rubber couplings between the turntable and the motor. Again, in order to avoid change-overs and the possibility of rupture of the turntable couplings, it is well not to allow the temperature of the projection room to be less than 60 degrees Fahrenheit. In addition, it is well to allow the projection machines to run for at least fifteen minutes prior to the opening of the show in order to warm up the drives.

If suitable means are not available for heating the projection room it is suggested that some type of electric heater, or even a 100-watt lamp, be arranged to heat the drives, thereby assuring proper change of speed and elimination of the possibility of a shut-down due to broken turntable couplings. Under no circumstances should projectionists use a lighter grade lubricant than specified, for faulty oiling must surely result in expensive damage to the equipment.

It is well for the operatives to compile a log of all the

difficulties which may require attention and give them to the service inspector when he arrives at the theatre.

In certain sound equipment, storage batteries supply the magnetizing current. These have been eliminated in the more advanced models, but for the benefit of the managements that are still operating under storage batteries the following information is offered. (The batteries referred to are in connection with the Western Electric System.)

One set of storage batteries, called the H batteries, is used to supply magnetizing current to the receivers attached to the horns, and two other sets, F1 and F2, supply filament current for the amplifiers, exciting lamps, etc. The F1 and F2 sets are used alternately, one set being on charge while the other is running. It is very important always to follow this practice. It is necessary in order to maintain the charge and insure adequate filament power for every show.

The A and H storage batteries are to be operated in two sets. A-1 and H-1 constitute one set; A-2 and H-2, the other. Whenever one set is running the other should be on charge. By always charging one set (at the rate adjusted by the engineer) while using the other the charge will be maintained. Ordinarily, when running short numbers, use the A-1, H-1 batteries for all performances one day, and meanwhile keep the A-2, H-2 batteries on charge. The next day, use the A-2, H-2 and charge the A-1, H-1. Keep alternating the batteries in this manner each day. If you are using your batteries for a total of seven hours or more a day, as in the case of synchronized scores for feature pictures, use the A-1, H-1 set for the afternoon show, and the A-2, H-2 for the night show. Change over from one set to the other after half of the day's show has been run, and of course keep on charge the ones not being used. If, under the above regulating programme, the batteries

tend to lose their charge, it may be necessary to charge them for a longer time than they are used. It is therefore necessary to check the condition of the batteries every day. Measure the specific gravity of the acid in the batteries by the use of the hydrometer. For this purpose, select one cell in each of the four battery groups—A-1, H-1, A-2, and H-2—for use as a pilot cell and read the gravity in each of these four cells by removing the filling cap and drawing enough acid into the hydrometer barrel to lift the float. After reading, replace all the acid withdrawn and put the cap back. Never measure the gravity just after adding water. Wait until the battery set just used (if the reading in either pilot cell is below 1250) continues charging until both pilot cells are up to this figure, indicating full charge. On the A and H battery set just used, a reading below 1200 in either pilot cell indicates that the set has been used too long without charging. Give it a full charge to bring the gravity up to 1250 as soon as possible, and alternate the sets more often. Batteries will not permit satisfactory operation, or their life will be shortened, if the gravity is allowed to go below 1200. The B batteries should be recharged as soon as any pilot cell gets below 1230. Continue the charge until all pilot cells are up to 1285.

The F batteries should be treated in the same manner as the A and H batteries.

The B batteries do not need to be charged every day, but will require charging two or three times a week, as indicated by hydrometer readings.

It will be relevant, at this point, to say something concerning Battery Charging Panel (1-FD). This panel is mounted in a metal cabinet on the wall and is used for charging the storage batteries. In the upper part of the panel are two six-pole double-throw knife switches. The switch on the left controls the A-1 and H-1 batteries, and the one on the right the A-2 and H-2 batteries. Each

switch connects its set of batteries, either for charging or for operating, according to the way it is thrown, as marked on the panel.

At the bottom of the panel are two four-pole double-throw switches. The left-hand switch controls the F-1 batteries, the right-hand switch the F-2. Each switch connects its set of batteries for charging or for operating, according to the way it is thrown, as marked on the panel. If the installation does not have film pick-up equipment these switches are, of course, not used. On A. C. supply a charger is used to rectify the A. C. and deliver D. C. of the proper voltage for charging the various batteries. Putting either of the switches for the A and H batteries in the charging position automatically starts up that part of the charger which supplies current for the batteries involved. The charger has a control for regulating the A and H battery charging rate. This control must be kept set at the point indicated by the engineer. When either of the F battery switches is in the charging position, the charger automatically supplies F battery charging current. On D. C. supply charging, current controls are used for regulating the charging rate for the A, H, and F batteries. The controls must be kept set at the point indicated by the engineer.

Meters are provided for reading the charging current through the batteries. The A and H batteries are so connected that the charging rate through each unit is one half the reading on the meter. The operator will not ordinarily need to read any of these meters, because they are principally intended to assist the engineer in adjusting the charging current controls.

The panel has the following fuses:

Line Circuit—Two 20-ampere cartridge fuses.

Amplifier Filament Circuit—One 15-ampere cartridge fuse in the negative side.

Horn Circuit—One 15-ampere cartridge fuse in the negative side.
Monitor Horn Circuit—One 3-ampere cartridge fuse in the positive side.
Film Circuit—One 10-ampere cartridge fuse in the positive side.

Each fuse is located beside the terminal of the circuit with which it is associated.

The charger employed on A. C. supply uses three No. 189049 Tungar Bulbs, or two when there is no F battery. It has two 15-ampere plug fuses for the A-H charging circuit, and one 15-ampere plug fuse for the F charging circuit.

In addition we have Battery Charging Panel (2-FD). This panel is mounted in a metal cabinet on the wall and is used for charging the storage batteries. In the upper right-hand part of the panel are two six-pole double-throw knife switches, one above the other. The top switch controls the A-1 and H-1 batteries, and the lower switch the A-2 and H-2 batteries. Each switch connects its set of batteries either for charging or for operating, according to the way it is thrown, as marked on the panel. At the bottom of the panel are two three-pole double-throw switches. The left-hand switch controls the F-1 batteries, the right-hand switch the F-2. Each switch connects its set of batteries for charging or for operating, according to the way it is thrown, as marked on the panel. If the installation does not have film pick-up equipment, these switches are, of course, not used.

The fifteen B batteries are divided into five groups of three each. These units are charged in parallel and discharged in series. In the upper left-hand corner of the panel are a seven-pole and a five-pole double-throw switch. The seven-pole switch at the top controls three of the B battery groups, and the five-pole switch below it controls

the other two. Each switch connects the associated batteries for charging or for operating, according to the way it is thrown, as marked on the panel. On A. C. supply a charger is used to rectify the A. C. and deliver D. C. of the proper voltage for charging the different batteries. Putting either of the switches for the A and H batteries in the charging position automatically starts up that part of the charger which supplies current for these batteries. The charger has a control for regulating the A and H battery charging rate. This control must be kept set at the point indicated by the engineer. When both B battery switches are in the charging position the charger is automatically connected for charging the B batteries. When the upper B battery switch and one of the F battery switches are both at "charge" the charger supplies F battery charging current. On D. C. supply charging, current controls are used for regulating the charging rate for the A, H, and F batteries. These controls must be kept set at the point indicated by the engineer. The charging rate for the B batteries on either A. C. or D. C. supply is controlled by a fixed resistor enclosed in the upper part of the panel box. This resistor does not require any attention on the part of the operator. Meters are provided for reading the charging current through the A and H batteries, the B battery and the F battery. The A and H batteries are so connected that the charging rate through each unit is one half the reading on the meter. The operator will not ordinarily need to read any of these meters, as they are principally intended to assist the engineer in adjusting the charging current controls.

The panel has the following fuses:

Plate Circuit—One 3-ampere cartridge fuse on the positive side of 130 V; and one in the positive side of 350 V.

Line Circuit—Two 30-ampere cartridge fuses.

AMPLIFIER FILAMENT CIRCUIT—One 15-ampere cartridge fuse in the negative side.
HORN CIRCUIT—One 15-ampere cartridge fuse in the negative side.
MONITOR HORN CIRCUIT—One 3-ampere cartridge fuse in the positive side.
FILM CIRCUIT—One 10-ampere cartridge fuse in the positive side.

Each fuse is located beside the terminal of the circuit with which it is associated.

The charger employed on A. C. supply uses four No. 189049 Tungar bulbs; or three, when there is no F battery. It has two 15-ampere plug fuses for the A-H charging circuit, and one 15-ampere plug fuse for the F charging circuit.

Now a final word concerning dry batteries for the film: Dry batteries are used to operate the photo-electric cell and furnish plate voltage to the film pick-up amplifier. These batteries are kept in a metal case in the battery room. This folder contains three 22½-volt batteries and two 45-volt batteries, and is provided with terminal blocks for connecting the batteries to the line. Normally, the two 45-volt batteries and one of the 22½-volt units are used; the other two 22½-volt units are kept as spares.

If the storage batteries are to realize their full life and cause no trouble they must have proper care and attention. The following points are for this reason very important: Never put anything into a storage battery except clean *distilled* water! Battery makers put a certain amount of acid, diluted with water, into each cell when it is new, and no more acid is necessary. As the water evaporates, it must be replaced from time to time so that the solution keeps the plates completely covered. *Every week*, on the pilot cells—and *every two weeks* on all the other cells—look at the acid level! To do this, remove the caps and use a

flashlight to illuminate the cell interior. The acid level should be about a quarter of an inch above the top of the plates. It should never be allowed to get down to the very top of the plates; on the other hand, it should not touch the bottom end of the filling tube. Add the necessary amount of water by running it in slowly before charging. Batteries require more water in hot weather than in cold weather. Distilled water may be obtained at any drug store or battery service station. It is best to buy it in large bottles of one-gallon to five-gallon capacity and fill the cells either directly from the bottle through a rubber tube or else by a special filling cup. Do not use a hydrometer for this purpose. Once each week wipe off the battery tops and connectors with a rag moistened in a solution of baking soda in water, or a solution of household ammonia and water in equal parts. Occasionally, after cleaning, coat the battery terminals with vaseline. If, for any reason, batteries are not in use, keep them fully charged. Test their gravity and add water once a month. Connections must be tight at all times. Keep the battery room constantly well ventilated.

Although the above constitutes an up-to-date, complete account of the gross elements of equipment and a detailed survey of their use and care, anyone handling the devices will find constant need of consulting engineers' or manufacturers' manuals. To facilitate understanding of the terms used by such experts or publications I have compiled in the Glossary of this book a list of expressions which offer further information that has been found useful by managers, projectionists, and other members of the theatre staff. It might be wise for each operator to have such a list copied or compiled to suit his needs and those of his employees, old or new.

CHAPTER V

ACOUSTICS

UNDERLYING the equipment of both theatre and studio is a body of scientific principle and mathematical computation. The aim of the present chapter is not to explain these; they are the exclusive province of the technical expert and theorist. Yet I devote a portion of the book to the subject in order to point out the more significant practical applications and to emphasize the importance of the science itself.

Hitherto, the all-important consideration in motion picture theatres has been clear and ready visibility. Audibility, always a matter of some concern to the motion picture theatre architect and to the management, now becomes a major—perhaps *the* major—problem in theatre construction. I am not referring only to the sharp distinctness of the reproducing apparatus. I am thinking especially of the fitness of the auditorium itself as an auxiliary to perfect reception by the ear. We know that whereas the voice will boom unnaturally in an empty salon it will be natural in tone when there are a great many people present. Footsteps that echo in a stone corridor are inaudible in one that is carpeted and draped. What is the significance of these simple facts for the exhibitor of sound pictures?

The pages that follow will answer the question. Meanwhile I take occasion to stress this admonition: Although no theatre manager is expected to be a scholarly savant, he cannot expect any success at all in connection with sound unless his theatre conforms to the requirements of science

in the matter of hearing. And since he knows better than to expect to take care of the matter himself he must not only rely on the expert who knows, but must know enough, himself, to coöperate effectively. He must look at his house from this angle as a thing to be learned all over again.

The matter of acoustics presents one of the most important problems in the installation of sound equipment in studios as well as in theatres; for upon the correct principles will depend, in a large measure, the value and quality of good installations. There is no longer any justification for bad auditory conditions since there is an ample and exact science of architectural acoustics which can be applied in the correction of existing auditoriums that may be found faulty, or in the designing of new studios or theatres.

If patrons are to enjoy sound pictures it is obviously important to produce comfortable conditions of hearing. The results of researches in this field have been made available in a practical and commercial form. With the expert assistance that is now at hand, and with the materials that have proved of value in bringing about the proper results, a technique of construction has been developed through experience that will solve most difficulties of this sort. It has long been customary, in the vast majority of cases, to design theatres at considerable expense, with special efforts to secure strength, speaking capacity, fine architectural lines, æsthetic illumination, and proper ventilation. Yet there has always been a gamble as to whether the acoustics of the auditorium would be good or bad.

In a theatre this neglected problem equals in importance that of lighting, heating, or ventilation; but, although some consideration has been given to the matter in the past, it is only recently, because of the introduction of sound motion pictures, that the real importance of adequate planning has been realized.

The science itself is the result of many years of intelligent and intense research on the part of the late Wallace C. Sabine, who was Professor of Mathematics and Natural Philosophy at Harvard University; and the soundness of his study has been established beyond all question of a doubt by more than seventeen years of practical experience in acoustical design and correction. Before 1895 little information on the subject was available. Architects were guided in large measure by their own intuition and limited experience. Professor Sabine began studying the subject in 1895, and in 1900 published the result of his five years' work in the *Engineering Record*. This was the first real contribution to the science as we know it; and because of his efforts and the scope of his studies the chances of conjecture of acoustics were done away with and the problem was put on a mathematical basis.

The research was motivated originally by the fact that Harvard University, after completing the Fogg Art Museum, found that the auditorium it contained was useless for lectures. In their difficulty the authorities appealed to the scientific staff of the faculty for advice and assistance. Thereupon Professor Sabine undertook the study of the emergency and, as a result, developed a new branch of science. So completely and carefully did the professor carry out his work that subsequent investigators have done but little in the way of extending the theoretical foundations he laid down. For the most part they have merely enlarged upon our knowledge of the acoustic properties of various materials used in building construction. The principles and the practical application gained from Professor Sabine's work and augmented by that of others who devoted themselves to the subject made it possible to determine from the plans of a public building, together with facts concerning the materials of construction, what the acoustical conditions in the completed building would be,

so that changes could be prescribed to anticipate defects.

Therefore we now have a solution of the riddles of reverberation and echo; and it is possible, as I say, to predict acoustic properties from plans and specifications, to point out the particularly defective features of any proposed construction, and to specify the necessary remedy. Professor Sabine's methods are thus not only thoroughly scientific, but also of remarkable practical use to the architect as well as the engineer. No studio or auditorium, large or small, should be constructed unless it is designed in accordance with these principles.

In the new domain of our industry, the degree of fidelity of the reproduced sound to the original is dependent equally upon the acoustics of the producing studio and upon the recording apparatus. Therefore it can readily be seen that proper acoustical treatment is of importance not only in the studio, where the sound is first recorded, but also in the theatre, where sound is exhibited.

Now, the most common defect in acoustics is reverberation. This may briefly be defined as a reëcho; that is, the sound is prolonged unduly before its energy is exhausted. In recording one of the important acoustic characteristics of a room is its so-called time of reverberation. Experiment has proved that the shape of the room and the distribution and character of the damping surface play a part in the excellence of recording, but the time of reverberation is probably the most important single factor.

In order to get a natural sound record in a studio microphones are so placed as to imitate our ears; and in order to establish good acoustical conditions the walls are covered with soft absorbing materials. The problem of deadening existing walls and floors is quite as important a matter of construction as that of introducing deafening materials later. Since the importance of the former element has not been appreciated, carpets or absorbent materials are used

for the floors of chambers requiring correction. Even the materials used for scenery are being given special attention, to secure ideal acoustical conditions; for the problem here is the elimination of unwanted reverberation by any and every means. All who have the problem to deal with realize that the highest degree of perfection is needed. Therefore, engineer and scientists are continually searching for better methods. The experience gained in broadcasting over the radio has in this way been of great benefit in solving the problem of the motion picture sound stage.

Of course, it is the particular task of the producer continually to improve and refine studios and recording apparatus to capture the last measure of tone quality and of delicate moods of expression. Yet much of this improvement will be of no value if the reproduced sound is distorted in the theatre by faulty conditions. Although the study of acoustics is of a highly technical nature, and although much of the success to be attained must necessarily be the contribution of experts, nevertheless, the various factors pertaining to the problem ought to be a matter of common knowledge, so that all who are concerned may realize the importance of the subject and the possibilities of control.

The reproduction of sound occurs generally in large auditoriums where hundreds or thousands of persons may be accommodated. The ideal is to fill the room equally with faithful sound so that each person can hear well. The degree of fidelity with which the sound is reproduced will depend to a great extent on the acoustics of the theatre itself. Keep this in mind: *The acoustical condition of a theatre cannot add anything to, or improve on, the original recorded sound.*

The acoustics of a theatre depend upon three factors: the size, the shape, and the materials comprising the interior finish. In order to understand the effect of these

factors upon the ears of the audience it is necessary to know something about the propagation of action and sound in a room. Sound spreads in spherical waves from its source, and the loudness or intensity decreases as the square of the distance. Thus, in the open air sound loses its "carrying qualities" at no great distance from the source, and there are complaints of lack of distinction.

In different types of auditoriums the nature of the surface of the walls, the ceiling, the floor, or of other extensive areas, is the principal factor. Surfaces that are soft and thick, such as stage drapes, heavy curtains, carpets, upholstered theatre chairs, or the clothing of the audience, absorb or disperse sound waves. Elaborate ornamental plaster acts in the same respect. However, the quality of building materials reflects sound to the highest degree. Most building interior finishes, for instance, absorb only from 1 per cent. to 4 per cent. of sound (96 per cent. to 99 per cent. of the sound striking them being reflected). The result is that, as a prescribed area is surrounded with walls and then a ceiling, sound which would otherwise be rapidly dissipated in the open air is reflected from the walls to the ceiling, ceiling to floor, and floor to walls again, many times, with the outcome that much of this reflected sound reinforces and amplifies the original. What is the effect? A more even and a greater distribution of loudness than would be possible otherwise. To this extent the evolution of the modern theatre has been the means of providing increased and more equably distributed intensity in even extremely large auditoriums.

On the other hand, the increasing demands of sanitation and fireproofing have brought about the production of harder and more dense interior finishes, so that the quality of sound reflection in materials has sometimes been overdone.

Sound distribution in a theatre is quite similar to air

distribution. In ventilation, concentration of forced air must be avoided because of noise and draughts. Therefore, diffusion must take place, and to this end the auditorium walls and ceiling are used to spray new air, equally distributed over the audience. The process, if accomplished scientifically, is beneficial; it neither distracts attention nor causes discomfort. Similarly the mathematical determination of the effects of porosity and flexibility in all the materials to be used in the interior finish and furnishings of a theatre is necessary in deciding just what treatment the acoustical engineers are to give the walls and ceiling to insure good effects.

When a sound wave travelling in the air reaches a wall it communicates itself to the wall and is converted therein into waves of exactly the same shape and of the same number per second but of rather smaller size; for a little of the power is lost in transferring the waves from one medium to another. The extent of this weakening depends upon the thickness and on the material and structure of the wall. However, because sound is produced by waves, it can be focussed, refracted, and reflected, just like light. When reverberation is present in excessive amount it may cause an overlapping and blurring, especially annoying in the case of speech. It must likewise be borne in mind that when reverberation is reduced, loudness diminishes in almost the same ratio; therefore, to allow for both conditions, the proper point must be determined.

Since the action of sound may be calculated in a precise manner the proper corrective measures may be prescribed to reduce reverberation to the amount best suited for the auditorium under consideration. Reverberation increases, for instance, with the size and height of the room. It may also be reduced in auditoriums that have balconies which contain heavily upholstered seats or that have other recesses in the construction. Excessive absorbent materials

may cause sound in an auditorium to appear dead and dull. Contrarily, when a surface consists of thin, hard material, resonance may increase. Frequently, moreover, the architecture or layout of a theatre may be such that proper facilities cannot be obtained. Under such circumstances the condition must be improved by the use or modification of the materials for the interior finish. Large, flat, unbroken wall or ceiling areas are often objectionable, since they produce echoes and reverberations. Windows or windbreaks that have large surfaces of glass may likewise provide troublesome reflections. Deep shafts and wells may introduce local reverberations. Extensive domes may cause concentrated or focussed reflection. Crystal chandeliers and loose metal plates, if not properly installed, may vibrate and give off foreign noises.

Thus a second criterion, that of shape, enters into the problem. The contour of the walls and ceiling determines to a considerable extent whether or not the reflected sound will reinforce the original in such a manner as to provide even distribution, or whether the reflected sound will be concentrated at certain points of the auditorium to its detriment at other points and in that way result, perhaps, in distinct echoes.

As indicated earlier in this chapter, the number of people in an auditorium has a decided effect because of the fact that the clothing of people absorbs sound. Thus, when patrons fill a theatre the entire floor is carpeted with a material that is almost totally absorbent of sound and so increases the rate of decay or reflected sound as in many instances to eliminate confusion.

In a theatre it is possible to alter and adjust the sound-absorbing and sound-reflecting character of the interior finish either by covering existing walls and ceilings with special sound-absorbing interior finishes or by providing for the use of these materials in the case of theatres under

construction. The sound-absorbing qualities of all modern building materials are well known. Therefore, it is possible to measure the acoustical effect mathematically and with exactness and to design interior finishes which will bring about the desired improvement in the auditory properties.

The customary method employed in securing sufficient absorption is to introduce the requisite amount of felt for the auditorium under treatment. The surfaces that are so treated are afterward covered and protected with a decorative fabric. The choice of the quality of the fabric depends a great deal on the treatment necessary. A special fabric coating is used, generally, in order not to affect the absorption quality.

Acoustics may be improved, when properly handled, without mutilation of the architectural design. Frequently, good results may be obtained by changing the shape and contour of walls and ceilings. If this is done properly the installations can be effected without interfering with the decorative value of the theatre. The treatment by means of the absorbing materials must necessarily be entrusted to experts, because the degree of reverberation should be determined only after technical analysis and because it depends to a great extent on the type of room or auditorium to be altered. Finally, sounding boards are frequently of value in bettering acoustical conditions. When properly designed and blended into the decorative treatment of the theatre they may prove of great value.

Most motion picture theatres are sufficiently good acoustically for the satisfactory audition of incidental organ and orchestral music, but there are many that are too reverberant for the comfortable audition of speech. If speech is to be heard with ease and comfort each syllable must stand out clean cut and distinct, particularly when sound is introduced in connection with motion pictures.

All sounds of speech and music are complex in nature.

They consist of several so-called partials. The predominating partial is known as the fundamental tone. The relative intensity of all the upper partials gives colour and character to this fundamental. If the sound-absorbing interior finish of a room has the effect of blotting out the upper register to a greater degree than it does sounds of the lower register, it washes out the upper partials and overtones which give a certain quality to music. Since in music the overtones and partials provide quality and character to the fundamentals it is desirable to use materials to absorb the same amount of sound over the entire scale of pitch, so that orchestrations may be maintained in their original relationship. It can readily be seen that this factor has a very decided influence on the fidelity with which sound films are reproduced in a theatre.

Ventilating equipment must be designed before installation so that the noises caused by the rush of air through grilles, coiling, and walls should not enter the theatre. Hangings are an aid in perfecting acoustics, and carpets used in the aisles, corridors, etc., prevent noise from walking and from the shuffling of feet.

It is characteristic of all building materials, and sound-absorbing finishes as well, that they absorb much more sound in the higher frequencies above 250 cycles per second than below 250 cycles. This has a noticeable effect in the manner of emphasizing the bass at the expense of high-pitch instruments and voices, and also has a considerable detrimental effect on tone quality.

The size and shape of an auditorium determine the distance travelled by the sound between reflections, while the materials used in the construction determine the loss at each reflection. It is therefore possible for two auditoriums to be designed exactly alike and yet have entirely different acoustical characteristics. The Mormon Tabernacle at Salt Lake City illustrates a remarkable acoustical

salvation brought about by the material used in construction. The design could not be worse from an auditory point of view. The shape of the ceiling, for example, is responsible for the unusual echo. The building, however, is made of wood, which, having the highest coefficient of sound exhaustion of any material, makes the acoustic properties quite satisfactory.

There have been instances of attempts to overcome the deficiencies of a room by installing wires in certain positions. There is no scientific basis to justify their use; anyone familiar with the fundamentals of sound must readily realize that there can be no real improvement because of such installation. It has been claimed that an echo can be broken by stretching wires in front of the offending surfaces. Experiments have proved this not to be so. Sound waves pass through the wires with practically no change.

Echo, in the usual sense of the term, means a definite or articulate repetition of a sound after an interval at least equal to the total duration of the sound that is being repeated. For the average ear the interval must be greater than one twelfth of a second if echo is to be noted. Thus it differs from reverberation, which is a confused or inarticulate but unbroken prolongation of the sound. Echo is always a bad feature. Reverberation, on the other hand, is desirable up to a certain point; only in excess is it an evil. Of the two echo is the more difficult to remove; the best procedure is prevention by foresight in construction, aided, if necessary, by expert advice.

Echo arises by regular reflection of sound from smooth walls, ceilings, or proscenium arches, just as a mirror may reflect a beam of light without scattering it. If, however, the surface of the mirror be roughened, the reflected light will be diffused in all directions; and if the walls and ceiling of a room be similarly made irregular (on a sufficiently

large scale, the reflected sound will be scattered and broken up and its definite or articulate character destroyed. Then what we have is called reverberation.

The lapse of time before an echo is heard is due to the greater distance it travels as compared to the path of the original. This difference of path may be such as to cause much mischief; for the reflected sound of a spoken syllable or of a note of music may, and often does, arrive at the ear at the same moment as the succeeding syllable or note which has travelled by the direct path and so cause hopeless confusion.

Smooth, hard-finished walls, such as the usual plastered type, are excellent regular reflectors of sound and are consequently likely to produce echo. It becomes of importance, therefore, to break up such surfaces in order to produce irregular distribution of the reflected sound. The scattering in the case of ceilings is usually accomplished by what is called "coffering." Examples may be seen in many theatres of modern construction. The ceiling and perhaps the proscenium arch are broken up into depressions about four feet square, containing a succession of steps totalling a depth of, perhaps, eight or ten inches. An irregular surface of this character breaks up the reflected sound and distributes it in such a way as to minimize echo and, in fact, to convert it into reverberation. The dimensions which should be assigned to such coffering are not a matter of taste or accident. If the wave length of the incident sound is very large compared to the size of the irregularities it encounters there will be little dispersive effect produced; while, if it is very small, the smooth spaces inside the coffering may act as regular reflectors.

In addition to their own damage reflection produces other evils known as "dead spots and sound foci." Sound travels through the air as a wave of alternate compression and rarefaction, or contraction and expansion. If a reflected

sound wave is retarded by the proper amount it may happen that the compression of the directly transmitted sound meets the rarefaction of the reflected sound at the ear at the same time. They thus neutralize each other's effect and produce a diminution in intensity. This is called a "dead spot." If a reflected sound is retarded a little more it may happen that two compressions coincide, producing an unusually loud sound. This is a sound focus. The most usual cause of such sound foci is a curved wall or ceiling which concentrates the sound to a focus.

Since dead spots and sound foci arise from the same cause as echo their removal may be brought about by the same treatment. Some care and experience are necessary in order to locate the particular portion of the room which is responsible for the production of a dead spot. Often this can be found only by trial-and-error experiment, since it is not possible to predict the path of reflected sound with the same accuracy as that of light. The offending portion, once found, must be treated in such a way as to decrease its power of regular reflection.

Professor Sabine mentions the case of a theatre, the ceiling of which contained a flat oval panel, to which the trouble was ultimately traced. In this case an irregular canopy, oval in plan and slightly larger than the panel, was hung just below it, with good effect.

Since a sound produced in a room is reflected back and forth from walls, floor, and ceiling, and since a portion is absorbed at each reflection, its intensity is finally so reduced that it becomes inaudible. Owing to the high speed of sound there may be many such reflections in the course of a single second in a room of ordinary size; and the greater the dimensions of the hall, the more prolonged will be the reverberation. If the walls of the room are covered with some highly sound-absorbent material, such as hair felt, two or three reflections may suffice to destroy the

sound. Such a room is acoustically "dead" and undesirable. A little reverberation is necessary to satisfy our established auditory taste and habit. The desired amount of reverberation is found empirically to increase with the size of the auditorium.

Because of the pioneer work of Sabine it is possible to define the "reverberation time" of a room (perhaps somewhat arbitrarily and artificially) as the time required by a sound of specified intensity to die away to inaudibility. This standard intensity is a sound ordinarily painful to a normal ear at close range, and is difficult of reproduction. Fortunately, its use is not necessary in ordinary practice, for since Sabine's day the "reverberation time" of a room is a matter of calculation rather than experiment. The method of making the calculation I will explain later.

Experience with a number of existing auditoriums of acceptable acoustic quality makes possible the formulation of the following table, in which the acceptable limits of the standard reverberation time are expressed for rooms of different volume.

TABLE I

VOLUME OF ROOM IN CUBIC FEET	ACCEPTABLE LIMITS OF REVERBERATION TIME IN SECONDS		VOLUME OF ROOM IN CUBIC FEET	ACCEPTABLE LIMITS OF REVERBERATION TIME IN SECONDS	
	Half Audience	Maximum Audience		Half Audience	Maximum Audience
10,000	0.9–1.2	0.6–0.8	400,000	2.1–2.3	1.7–2.0
25,000	1.0–1.3	0.8–1.1	600,000	2.3–2.6	1.8–2.2
50,000	1.2–1.5	0.9–1.3	800,000	2.5–2.8	1.9–2.3
100,000	1.5–1.8	1.2–1.5	1,000,000	2.6–2.9	2.1–2.5
200,000	1.8–2.0	1.4–1.7			

The limits given in the table are not to be regarded as rigid. Some auditoriums are known to exceed these limits in either direction by several tenths of a second, and yet are of fairly satisfactory quality. However, in planning a new auditorium it should be the aim to strike the average of the range which the table provides.

The varying absorptive powers of different materials make an interesting study. The most complete absorber known is an open window! It is theoretically possible that a small amount of sound may be sent back by diffraction from the edges of the window, but this quantity is so small that it is permissible to say that an open window is a perfect absorber. The next most perfect absorber of sound is probably hair felt, which consumes perhaps half as much sound as an equal area of open window. In other words, it may be said that since an open window absorbs (or transmits) all the sound that falls upon it, its coefficient of absorption is unity. A sample of building material will reflect 99 per cent. of the sound striking it. The same surface covered with one inch of hair felt (the best sound absorber) will reflect only 47 per cent. of the sound. Increasing the thickness of the felt will further reduce the percentage.

The harmful effects produced by a dome, a curved ceiling, or pendentives cannot be entirely overcome by acoustical treatment, because such surfaces cannot be made totally absorbent. When they are used the centre of curvature should be located a considerable distance from the location of seats. Surfaces covered with felt one inch thick will absorb 53 per cent. of the sound energy striking it. There will still be reflected 47 per cent., sometimes sufficient to be a source of complaint.

Because every substance may be said to have its own absorption coefficient, Sabine was able to determine constants for a number of common materials, and later work-

ers have extended the list. The coefficients of some of the more common materials are given below.

(1 square foot each):

Open window	1.000
Wood sheathing (hard pine)	.061
Plaster on wood lath	.034
Plaster on wire lath	.033
Glass	.027
Plaster on tile	.025
Brick	.025
Concrete	.015
Glazed tile	.01

Following are some miscellaneous coefficients which are of interest.

(1 square foot each):

Carpet	.20
Cheesecloth	.019
Cork 2.5 centimetres thick, loose on floor	.16
Audience per person	4.7
Hair felt 1 inch thick	.53

NOTE: *It is frequently of assistance to compare the reflection of sound waves with the reflection of light waves. A white ceiling will reflect about 95 per cent. of the light striking it. The same surface painted a dull black will reflect at the most but 5 per cent. of the light.*

Table 2 gives the absorption coefficients of a number of substances. Strictly speaking, these coefficients will vary somewhat with the frequency of the incident sound. In Table 2 the values given are for a frequency of 512 (Watson).

In Table 3 there are recorded values of the total absorption of individual objects; and in Table 4 the absorption coefficients of various substances for different sound frequencies, as determined by the Bureau of Standards.

TABLE 2. SOUND ABSORPTION COEFFICIENTS

Akoustolith (artificial stone)	0.36
Brick set in Portland cement	.025
Brick wall, 18 inches thick	.032
Brick wall, painted	.017
Carpets, unlined	.15
Carpets, lined	.20
Carpets, heavy, with lining	.25
Carpet rugs	.20
Celotex, one-half inch thick	.31
Cheesecloth	.019
Cocoa matting, lined	.17
Concrete	.015
Cork tile	.03
Cretonne cloth	.15
Curtains, chenille	.23
Curtains, in heavy folds	0.5 to 1.0
Flax, 1 inch thick, with unpainted membrane	.55
Glass, single thickness	.027
Hair felt, 1 inch thick, with unpainted membrane	.55
Hair felt, 1 inch thick, with painted membrane	.25 to .45
Hair felt, 2 inches thick, with unpainted membrane	.70
Hair felt, 2 inches thick, with painted membrane	.40 to .60
Insulite, one-half inch thick	.31
Linoleum	.03
Marble	.01
Oil paintings, including frames	.28
Open window	1.00
Oriental rugs, extra heavy	.29
Plaster on wood lath	.034
Plaster on wire lath	.033
Plaster on tile	.025
Stage opening, depending on stage furnishing	.25 to .40
Varnished wood	.03
Ventilators (50 per cent. open space)	.50
Wood sheathing	.061
Wood varnished	.03

TABLE 3. TOTAL ABSORPTION BY INDIVIDUAL OBJECTS

Audience, per person	4.7
Church pews, per seat	.2

House plants, per cubic foot	.0031
Seats, upholstered, depending on material and lining, per seat	1.0 to 2.5
Seat cushions, cotton, covered with corduroy, per seat	2.16
Seat cushions, hair covered with canvas and light damask, per seat	2.27
Settees, upholstered in hair and leather, seat and back, per seat	3.
Wood seats, for auditoriums, per seat	.100

TABLE 4. ABSORPTION COEFFICIENTS

MATERIAL	297	581	1,095	2,190	2,890
Glass	0.021		0.020	0.010	
⅝-inch celotex	.058		.056	.072	0.097
Celotex B	.178		.399	.734	.708
Sound-absorbing tile No. 1	.079		.116	.401	.35
Same No. 2	.078		.127	.201	.213
Hair felt, one inch	.330		.62	.94	.90
Brick	.019		.019	.056	.021
Pine wood	.012	0.009	.016	.016	.009
Oak wood	.011	.007	.011	.006	.005
Akoustolith		.301	.434	.380	.272
Brass	.021	.015	.023	.004	.001
½-inch insulite	.056	.102	.182	.256	.172
½-inch flax-li-num		.229	.312	.503	.336
1 inch flax-li-num	.182	.422	.456	.569	.407

To conclude, then: In planning an auditorium we must consider three factors—shape, size, and interior finish. As I said in discussing echo, the design of an auditorium should avoid curved walls or ceilings. An attempt to introduce such features for their artistic effect is almost certain to be detrimental to the acoustic quality of the room. Auditoriums of a rectangular shape have been the most uniformly satisfactory.

Prior to Sabine's work there was current an idea that there should be a certain ratio existing in the dimensions

of the room. Just what ratio, no one seemed to know certainly. Sabine quotes several different recommendations. Modern opinion regards such a ratio as immaterial unless, of course, the dimensions be carried to an absurd extreme, as in a very long and narrow chamber.

The question of size must be determined principally by the purpose for which the room is to be used and not by considerations of space available or seating capacity desired. True, modern amplifying practice makes it possible to use a very large auditorium for speaking, but the present discussion is limited to the consideration of natural features and characteristics. The degree to which amplification can be relied on to enable the use of large auditoriums depends, of course, on the degree of excellence of the equipment used. The best modern apparatus is capable of meeting very exacting requirements in this respect.

Generally speaking, a theatre should be moderate in size, although an auditorium for musical programmes, such as orchestral or choral performances, may be much larger. Such performances, however, usually include several vocal solo numbers, and the introduction of the voice rather limits the size of the room. Experience with existing auditoriums therefore leads to an empirical rule connecting the volume of the room with the maximum number of orchestral instruments suitable. No distinction is here made between wind and string instruments, which are supposed to be present in balanced quantity.

In case the orchestra is reinforced by the organ, due allowance must be made. The new music room at the Library of Congress is an instance in point. Its volume is about 100,000 cubic feet. At the opening concert there was employed an orchestra of twenty-six pieces, which, with the organ, produced an excessive reverberation, perceptibly spoiling the effect of sudden pauses after a loud

chord. The indicated limit for this room is perhaps twelve or fifteen pieces, with the organ.

As to interior finish, this should be planned with both echo and reverberation in mind. A liberal use of coffering on ceiling and on sloping upper walls should effectually prevent echo from these sources. The interior materials should be calculated to give a reverberation time as indicated by the average range in Table 1. Use should be made of panels of absorbing material in such quantity as may be necessary to reduce the reverberation time to a suitable value. Such materials, of several kinds, are now available commercially.

In certain large buildings, as in the dome of St. Paul's Cathedral, London, sound is so focussed that a whisper at one side can be distinctly heard at the other. A similar "whispering gallery" in the Hall of Statues at the Capitol at Washington has recently been eliminated by remodelling the ceiling.

Expert advice must always be sought in the handling of acoustical problems, and in this connection the best advice and the best materials are not only the most effective but the cheapest in the long run. The competent acoustical engineer, who has supplemented the theory of his science with years of practical experience, can determine or adjust the acoustics of any theatre to great exactness. It is important that theatre operators give this problem the attention that it deserves, for it is extremely difficult to live down a reputation for poor acoustics once it has been incurred.

What it all comes to is this: Sound means not only new equipment in the motion picture theatre, but, in a partial sense, a new theatre. For reasons I have stated throughout this chapter, no producer can possibly anticipate, no manufacturer of machinery can possibly anticipate, the special conditions of the individual building. If these, by

some rare chance, be completely suitable, then Providence has indeed been kind. The greater probability, however, is that structural material or architectural design (unless these have been adapted) will require some moderation to insure desired effects. The new art, like the new prima donna, has a proud jealousy of her own.

One fortunate phase of the necessity for alteration is that the building no longer is to be considered for mere passive housing of patrons. It now plays a rôle in their entertainment. Changes made in acoustical conditions may be looked upon, not merely as additions to rent, but as investment in improving service and fostering good will. Like decorative features, they more than pay their way; unlike them, they are indispensable. Modern science unsettles the imagination, at times, by giving inanimate matter a kind of mind or spirit. Radio—to give but one instance—has filled the air with voices. And now acoustics may be looked upon as a wizard, converting lifeless beams and stone into a great servant of the master Man. No longer merely a thing to keep out the elements, the building finds its tongue and lends its voice to that of the "speaking" film!

If this seem too fantastic, then let no one dismiss the fantasy without considering it in a practical light. At the very least, the voice of the walls must not break in upon the one that speaks from the machine! There must, at all costs, be harmony; and the special magic whose charm we must evoke is the rigid mathematical science called acoustics!

CHAPTER VI

OPERATING MANUAL

IF THIS text were addressed only to the general public the present chapter and the one following would undoubtedly be omitted. Yet I cannot fail to include them without depriving the book of some of its practical value for theatre operators. When a subject is well established one may venture to omit precise instructions, since it is likely that most people familiar with the field have already learned them. The reproduction of sound is surely not to be so regarded. Nor is it the main function of these pages to review or to classify things known, but to acquaint the industry with matters new and strange. Under the circumstances, I feel that I owe it to my readers in the field of operation to leave out no detail that may serve for guidance or reference. I therefore beg the forgiveness of the reader if I seem to turn from him to my brothers in the industry and speak to them of matters that intimately concern the conduct of our common project. To them I offer the opportunity of profiting from the recommendations of the Electrical Research Products, Incorporated, and the technical staff of the Fox West Coast Theatres.

The reader will have realized, from the perusal of what already has been said in this book, that in the comparatively short existence of this new art several different types and sizes of equipment have come into use, some to meet the diverse conditions of the theatrical field and some because of the steady progress that has been and is

being made. It can readily be understood that under these circumstances it would not be feasible, without danger of serious confusion or early obsolescence of the information, to attempt to cover all the details of operation of these various kinds of equipment as they have to be attended to by the projectionist, nor is it necessary, since complete operating instructions directly applicable to the type of equipment concerned are furnished with each installation.

There are, however, certain fundamental principles and procedures of operation and maintenance which underlie and are common to all the different detailed procedures, and which are not subject to early change; it is these which I wish to emphasize in this chapter and the next. These fundamentals cannot be disregarded without serious risk of apparatus trouble; on the other hand, if the theatre staff has an intelligent grasp of them the minutiæ of handling particular switches and levers will present little difficulty and will be largely self-evident.

Here is something I would like to emphasize, for it is indeed important: Neither the management nor the projectionists can afford to neglect the operating instructions supplied with each equipment by the manufacturer, for they have been carefully prepared on the basis of years of experience with such apparatus, and they are complete and up-to-date and adapted to the special conditions connected with each of the different types of equipment. Occasionally an installation may present one or two special features that are not covered in the standard instruction book; in such cases the installation and service engineers will give the necessary directions.

The operation of the equipment is not in any way a difficult, complicated, or mysterious matter, but it does require intelligence and a conscientious regard for the instructions furnished by the manufacturer; when troubles

occur a very large proportion of them can be directly traced to neglect or disregard of this rule.

I. General Operation of the Equipment

Two methods of recording, let me repeat, are in use. In the one, the record is made on a disk, under the trade name of "Vitaphone." In the other, the record is photographed on the film, under the trade name of "Movietone." Any theatre can be equipped for showing motion pictures by either. The only difference is in the apparatus used at the projector.

The film is threaded into the projector in the usual manner, except that great care must be exercised to have the proper sized loop, to avoid disturbing the synchronism, since the sound is registered $14\frac{1}{2}$ inches below the aperture, where the sound slit is located. After leaving the lower sprocket of the projector mechanism the sound film enters the reproducing aperture, where it passes over a sprocket that moves it along at a constant speed.

The projector driving mechanism consists of a gear box mounted on the same base as the motor. For disk reproduction it is coupled directly to the vertical extensible shaft by means of universal joints and to a second, or upper, gear box. For film there is a train of gears with a chain drive for the lower take-up. By means of these two sets of gears, the speed is reduced from 1,200 R. P. M. (revolutions per minute) at the motor shaft, to 90 R. P. M. at the projector machine drive shaft, which clears to a film speed of 90 per minute.

The motor is provided with a flywheel and a guard. The flywheel is directly coupled to the motor shaft by means of set screws. This is a special coupling; the set screws are used also to connect one shaft of the motor with the shaft of the lower gear box. The motor connections are

made of flexible Greenfield conduit and are permanently attached to the motor. When there is disk reproduction, turntable equipment is driven from the end of the motor opposite to the projector driving mechanism.

II. Motor Control Box

On the opposite side of the projector from the motor is the motor control box, connected with the motor by flexible conduit. The box has a knob, which is used to increase or decrease the speed when the switch is at variable operation. When the switch is thrown at regular operation the motor gives a speed of 1,200 R. P. M., and 90 R. P. M. at the flywheel of the projector, which runs 90 feet of film per minute, a standard footage of sound per minute.

The motor control box is provided with a milliammeter, and this milliammeter should show 5 to 20 mils after the machine is in operation. If this milliammeter does not register correctly, this is sometimes due to the line voltage conditions. A lead runs from the main switch to one of the primary taps numbered 2 to 6 on the transformer inside of the control box. If the line voltage is too low, or the meter reading is too high, or if the motor fails to come up to speed, move this lead to a lower numbered tap. If the line voltage is too high, or the reading meter too low, or if the motor tends to run away, move the lead to a higher numbered tap.

It is well to have the motor well warmed up by running ten to fifteen minutes before finally adjusting the tap connection.

III. Batteries

As mentioned in an earlier chapter, at the present time all Western Electric sound equipments use storage batter-

ies to a greater or lesser extent. The earliest equipments employed both high and low voltage batteries. The high-voltage set furnished 360 volts for the plate circuits of the amplifiers, and were known as the B batteries. The low-voltage batteries furnished a 12-volt supply for heating the amplifier filaments (A batteries), for lighting the sound lamp filaments (F batteries), and for magnetizing the receivers at the horns (H batteries). Since the plate voltage for the present types of main amplifiers is obtained by rectification, the B batteries are no longer being installed. The larger equipments still retain F batteries, to supply some of the amplifier tube filaments and the filaments of the sound lamps and indicating lamps and H batteries. The smaller equipments use the same 12-volt battery for both filaments and horns. It is worthy of note that in Western Electric installations the low-voltage batteries have been usually supplied in duplicate with the object that one set shall always be kept charged while the other is being used. This provision for alternate use obviates any danger of battery exhaustion, even in houses where the equipment operates almost continuously. The two sets are distinguished by numbers, thus: F-1, F-2, H-1, H-2, A-1, A-2. Duplication of the B batteries was not necessary, as the amount of current they had to supply was small compared with their charging rate. The batteries are put on charge, or connected to the operating circuit, as the case may be, by means of suitable switches mounted on panels enclosed in metal cabinets, various types having been used with the different kinds and sizes of equipments. On these panels each battery is usually connected to a switch having two positions, "Charge" and "Operate"; the position in which this switch is set then determines whether the battery receives current or gives it out. When the theatre power supply is direct current, rheostats are used in the battery charging

circuits to limit the charging current to the proper value. On alternating current supply, which of course cannot be directly used for charging, rectifiers are used to supply charging current at the required voltage.

Matters relating to the charging and general care of batteries are covered in the next chapter.

In systems employing the one F-D type battery charging panel, one set of storage batteries, called H batteries, are used to supply magnetizing current to the receivers attached to the horns. The two other sets, F-1 and F-2, supply filament current for the amplifier exciting lamps and indicating lights. The F-1 and F-2 sets are used alternately, one set being on charge while the other is supplying current. It is very important always to follow this practice, which is necessary to maintain the charge, so that adequate power may be available for every show.

In systems using the 40-type battery charging panel, there are two sets of batteries, number 1 and number 2, supplying current for the horns, amplifiers, filaments, exciting lamps, and indicating lights. They are used alternately, one being on charge while the other is supplying current. The length of time each set of batteries should be used before putting them on charge will depend upon the extent to which the equipment is used. In the case of the 1-FD battery panel, the charging period may be different for F sets, as compared with H sets. This makes it impossible to lay down any general rule as to how long each set should run. It is therefore essential to use the hydrometer supplied with the batteries to find out when each set needs charging. The charger, which is supplied with the sound equipment, is set for a given charging rate by the engineer who accompanies the sound equipment to the theatre. The charging switch on the A. C. charger may be kept on at all times, for the charger circuit is opened and closed by the switch on the battery panel. A storage

battery becomes discharged and loses its energy when the specific gravity falls below normal. To measure the gravity reading the hydrometer should be used. Never allow the gravity reading to fall below 1,190. Batteries should always have a gravity reading between 1,250 and 1,285 when fully charged.

To prepare for operation when using the 1-FD battery panel proceed as follows: Have the number 1-set at the operation switch for F-battery set which is to be used; the number 2-set at the charge switch for F-battery switch which is to be charged; and the number 3-set at the operation switch controlling the H batteries. When you are finished operating open all the above switches with the following exceptions: (1) if additional charging is needed for the F-battery set that has been on charge keep the switch controlling this set at charge until the gravity reading reaches full charge value; (2) if the H batteries need charging set the switch controlling them at charge and keep it there until the gravity reaches full charge value.

In operating the 40-type battery panel, to prepare for operation of equipment proceed as follows : (1) set in operation the switch for the battery set which is to be used; (2) set at charge the switch for the battery set which is to be charged. When you are finished operating open all the switches, unless an additional charging is needed for the set that has been on charge. In this case keep the switch controlling the set at charge until the gravity reading reaches the full charge value.

IV. Fader

To change from one projector to another without any interruption of music or sound, when using Western Electric sound equipment, it is necessary to use a potenti-

ometer, which is called the "fader." This fader has steps, up to fifteen. Usually a standard fader setting is given at each theatre. A master fader and also a dummy fader are provided with each installation. The master fader has all the electrical connections, and the dummy fader is an extension to an auxiliary operating point in the projection room. The two are coupled by means of a shaft. In order to balance the electrical characteristics of the system it is necessary to have input equalizers and input film attenuators in the system. The input equalizer is mounted underneath the turntable of the Western Electric universal base. The film attenuator is installed near the pick-up amplifier when the universal base is used. It is very easy to balance the volume between disk and film recording. The film attenuator is balanced with the input of the disk. When the universal base is not in use, the film attenuators and the disk equalizers are installed at the top of the amplifier panel rack.

The output of the amplifier system is set up on what is called an "Output control panel." This is where the sound is distributed to the various loudspeaking horns through separate output circuits. The horn switches, amplifier tubes, condensers, resistors, monitors and controls, and transformers are mounted on this panel board. Each horn has a separate control on the panel.

V. Horns

There are four types of horns being used in various theatres at the present time. The 12-A and 13-A horns were used exclusively until the 15-A and 15-B horns were furnished with installations. When you are using the 12-A and 13-A horns, the 12-A horns are usually placed about three-quarter distance up on the screen, to carry the vocal or the instrumental music in such fashion as to give per-

fect sound illusion. The 13-A horns are intended to give the necessary depth and fullness to the reproduced sound with the lower frequency. In theatres having more than one thousand seats, two 12-A and two 13-A horns are used. Theatres having fewer than one thousand seats are provided with two 12-A and one 13-A horns. The present 15-A horns replace the two 12-A horns and the one 13-A horn, and are installed alongside each other, instead of on top of each other, as in the case of the 12-A and 13-A horns. The 12-A, 13-A, and 15-A horns have a single throat. The 15-B type horns have a double throat and use four units. Two 15-B type horns are used for theatres of more than one thousand seats. They are also placed side by side and installed on the screen three quarters of the distance up. In exceptionally wide theatres three 15-B type horns are used. These are installed all together, alongside each other, to give even distribution throughout the auditorium.

The units for these horns are termed 555-W Western Electric Receivers. The sound current enters the receiver through the two terminals at the centre marked L-1 and L-2, and the magnetizing current enters through the two terminals at the side marked 7-V-plus and 7-V-minus. The magnetizing current required for each horn is $1\frac{6}{10}$ amperes. The circuits for the horns, including the speech circuits and the magnetizing circuits, pass through a metal cutout box located back stage and called the B-box.

VI. Amplifier and Rectifier Equipment

Before operating the equipment, it is necessary that the amplifier panel controls, which control the filament current, be turned on until the tubes warm up. This usually takes at least five minutes. The filament current for these tubes is therefore first switched on and regulated

while they are warming up. Next, the plate current is put on the amplifier and is regulated. After the amplifiers have been tested by means of a monitor horn they are ready for use. It is quite important to adjust the filament currents carefully to the specified values, for the low filament current will have a bad effect upon the value and quality of the sound, and the higher current will shorten the life of the tubes.

The original Electrical Research Products, Inc., equipments used amplifiers known as the 8-B, 9-A, and 10-A. The 8-B and 9-A amplifiers require a 360-volt storage battery for plate supply. The 10-A amplifier derives its plate supply from the 6000-A rectifier, which operates on 110 volts A.C.

The present types of amplifiers are known as the 41-A, 42-A, 43-A, and 46-B, and all derive their plate current from rectifying circuits contained in the 42-A, 43-A, and 46-B amplifiers. The 8-B, 9-A, 41-A, and 46-B amplifiers require 12-volt storage battery supply for their filaments. With the exception of the 46-B amplifier, which is mounted in a metal cabinet, all these amplifiers are panel type units, and may be combined as required to build up systems of varying capacities. The old type amplifiers are not, of course, used in combination with the present type.

Some of the foregoing amplifiers are provided with meters for reading the plate current or voltage, as well as the filament current. The readings of these meters must be carefully checked with the values given in the instruction book, as they are an important index to the condition of the tubes and amplifiers.

VII. Amplifier System

The amplifier system increases the weak currents from the reproducer, or the film amplifier, until they have

sufficient strength to separate the loudspeaking units. This is incorporated in one main amplifier panel with several different individual panels. Beginning at the top, the following list gives the names of the equipment on the front of the output control panel. Electrical Research Products, Incorporated, have installed a number of the 2-SX equipments.

OUTPUT PANEL

Theatre Horn Controls
Theatre Horn Keys
Monitor Horn Control
Monitor Horn Key
Input Key
(The key should always be kept in running position.)

41-A AMPLIFIER

Plate Current Meter
Gain Control
(The Gain Control is an emergency potentiometer, which can be used in case the main fader gives trouble.)
Filament Current Meter
Filament Control.
Plate Current Push-Buttons
(Please note that the plate current on all three tubes with 41-A amplifiers should be $1\frac{5}{10}$, and these readings should be well equalized. Provided they are not well equalized, it is necessary to change the tubes so that the meter reading is approximately or a little above $1\frac{5}{10}$. There are three Western Electric 239 type vacuum tubes. There is also a filament key on the 41-A amplifier panel. Please note that this switch must always be placed on the "on position.")

42-A AMPLIFIER PANEL

(This amplifier has two Western Electric 205 type vacuum tubes, and also two Western Electric 205 type vacuum tubes used for the rectifier. Please note

that these tubes cannot be used for the amplifier after they have once been used for the rectifier. There is also provided on this panel a plate current meter—also a starting switch for the 42-A amplifier.)

43-A AMPLIFIER PANEL

(This amplifier has two Western Electric 211 type vacuum tubes used in the amplifier—also two Western Electric 211 type vacuum tubes used in the rectifier. A starting switch is also provided.)

VIII. Starting and Testing

1. SYNCHRONOUS PICK-UP MECHANISM

Each day, before the house opens, projectionists should test the horns individually, lubricate the projector and pick-up mechanism, and check the operation. Two or three records or sound films should be on hand for the purpose. Records of piano, violin, or orchestra selections are most suitable. It is furthermore desirable that two copies of each record or two prints of each film be used. After starting and testing the amplifier equipment the mechanism and horns may be tested as follows:

1. Turn off all theatre horns. If individual dial switches are provided for each horn, set the controls at zero, turning all the way to the right. Keep the monitor horn on with the control at the usual setting.
2. On the fader, set the pointer at zero.
   If installation includes both film and disk reproduction, see that film-disk switching arrangement is set for the type of pick-up which is to be tested.
3. On each of the two machines which are to be used oil the universal joints on the shaft connecting the upper and lower combined disk and film and oil the following spots, which are all on the attachment mechanism.

Oil the hole in the hub at the inner side of the fibre driving gear. (On some designs this oil hole is replaced by an oil cup on the end of the main horizontal shaft.)

Oil the cup behind the fibre driving gear at the right.

Oil the cup behind the driving gear at the left.

Oil the cup on the spindle of the tension pulley for the take-up drive.

Oil the guide roller above the attachment sprocket. Separate the two halves of the roller by springing them apart with the fingers in order to get the oil to the centre of the spindle.

Oil the sprocket pad roller on the arm.

Oil the idler roller below the sprocket.

When the equipment is on a Simplex Projector, give the grease cup on the upper gear box a full turn. If necessary, refill with the grease furnished. Occasionally check to see that the grease channel is clear by turning the grease cup till grease is seen to come out beside the driving pinion inside projector.

4. On the two machines, set up two copies of one of the test records, or thread two prints of one of the test films, exactly as described in the next section (Setting up).
5. On each motor control box see that the regular switch is set at "Regular."
6. Set up the operator's and the observer's telephone sets. The manager, or someone else qualified to judge whether reproduction through the theatre horns is satisfactory, should now go into the theatre and stay within easy reach of the observer's telephone.
7. Start the first projector by means of the starting switch on the motor control box of the line switch for the motor control box.
8. Observe the reading of the meter on the control box. After the machine is up to speed the reading should vary somewhere between 20 and 30 mils, on A. C. supply; or 50 and 70 mils, on D. C. supply.

9. See that the projector mechanism is running freely; that the disk reproducer is tracking properly and has not jumped any grooves; and that the film is passing through smoothly.
10. Bring up the fader pointer to one step below correct setting for the record or sound film which is being played. The music or speech should now be heard from the monitor horn.
11. If a separate control is provided in the projection room for each theatre horn, turn all these horns on and then off again, one at a time. The observer, who ought to be near the stage, should listen to each horn in turn and check its operation. He should also be sure that the sound from each horn is clear, free of noise, and of full volume.
12. Put on all the horns, with the fader at correct setting, and see that the reproduction is satisfactory.
13. If the installation includes an emergency system, or an emergency set-up, switch over to each of these arrangements and see that the reproduction is satisfactory, using all the horns. Then switch back to the regular arrangement.
14. Stop the first machine by turning off the starting switch or the line switch. With the disk pick-up, put a new needle in the reproducer and set it back at the starting point of the record. With the film pick-up, rewind the film and set it back at starting point.

    Now start both machines and compare outputs for volume and quality by switching from one pick-up to the other on the fader.

    With film reproduction, low volume from one pick-up may indicate that the lamps are not adjusted to illuminate the film brightly enough, or that there is dirt on the lamp aperture or the film. If necessary to balance the outputs, change lamps or photo-electric cells. With disk reproduction, change the reproducers, if necessary, until two are found that match in volume and quality.

15. Put the fader on zero, stop the machines, and put away the test records or films.
    If the above tests are satisfactory the equipment is ready for operation.

II. FILM REPRODUCTION

To set up a sound film ready for operation proceed as follows:

1. See that the fader is at zero and that the film pick-up circuits are connected to it.
2. On the projector head, push in, as far as it will go, the small handle to which is attached the aperture sound-track mask.
3. On the projector, place the framing lever in central position. Move the projector mechanism by turning the motor flywheel so that the shutter cut-off blade is uppermost, the lens is open, and the intermittent has just ceased moving. Thread the projector mechanism with film in the usual manner, but be sure the loop, between the intermittent sprocket and the lower sprocket of the head, is such that the film just comes in line with the edge of the head.
4. Thread the film through the film pick-up attachment. In doing this, allow for slack between the lower sprocket of the machine and the attachment sprocket, a length of film equal to approximately two sprocket-tooth intervals.
5. It is important to allow film loops exactly as specified in 3 and 4, otherwise the synchronism between the sound heard from the horns and the accompanying action on the screen will not be perfect.
   Some films are marked to indicate which frame goes at the picture aperture and which at the lens aperture in starting. Cases where such markings are given form the only exception to the above rule, and the marking must then be followed.
6. After the film has been properly located on the attachment sprocket, release the tension pad so that it bears

on the film and holds it close up against the aperture plate in front of the lens tube.

7. On synchronized feature pictures, by starting and stopping the motor with the starting switch, run off as much film as necessary to bring the end of the "Part No." leader approximately up to the projector aperture.

IMPORTANT NOTE: *Projectionists should never attempt to stop or slow up a projector equipped for disk reproduction by holding the turntable, as this will cause damage to the apparatus and spoil the synchronism for the subject. The turntable coasts about four turns after the power is shut off. Never remove the record clamp or attempt to put it on while the turntable is revolving.*

III. DISK REPRODUCTION

To set up the record and film ready for operation, proceed as follows:

1. See that the fader is at zero and that the pick-up circuits are connected to it.
2. See that the reproducer is in rest. Put in a new needle.
3. Select the film and record to be used and be sure to check the number of the record against number of the film. Mark the record on label to show the number of times used, counting this run.
4. On the projector, place the framing lever in central position. Move the projector mechanism by turning the flywheel on the motor so that the shutter cut-off blade is uppermost, the lens is open, and the intermittent has just ceased moving. Thread the mechanism with film in the usual manner, placing the frame marked "Start" directly in front of the aperture.

On Simplex and Motiograph, this step is easier if it is remembered that when a frame is in front of the aperture the lower edge of the aperture plate track will be between the eighth and ninth sprocket holes from the lower edge of the frame. Therefore, splice a white leader on the

ninth hole from the "Start" frame. Then, when you line up this splice with the lower edge of the aperture place track, the "Start" frame will be at the aperture.

5. Set up the record on the turntable. In doing this, the following method must be strictly observed to avoid rush of imperfect synchronism or damage to records: the motor must never be turned when the adjusting record is on the turntable.

Hold the record with both hands and lay it on the turntable so that the starting arrow is at the place where the needle comes. Wipe off the record lightly with the cleaner provided. Pick up the forward end of the reproducer unit between the thumb and forefinger of your left hand so that the tips of the thumb and finger project about one-half inch below the bottom of the unit. Move the unit over until the needle point is above the starting groove. Rest the tips of the thumb and forefinger on the record surface in such a way as to hold the needle point just off the record. Place your right hand with the fingers resting lightly on the underside of turntable, near the edge, and the thumb on the tip of the record, near the edge. Hold the turntable steady and, by moving the thumb, turn the record so that the starting arrow comes exactly below the needle point.

Lower the needle gently into the starting groove, at this point, by slowly opening the thumb and forefinger between which it is held. Do not push the point into the groove by sliding it sidewise across the uncut record surface, but lower it straight down. When it is in place, rest the fingers lightly on the top of the reproducer and gently press it toward each side to make sure the needle point is in the groove. Put the record clamp over the centre pin of the turntable and press it down on the record firmly, but not too heavily. Turn the motor flywheel by hand until the turntable and record have revolved about half a turn.

See that the needle tracks properly on the record and that the film travels freely.

On synchronized feature pictures, by starting and stopping motor with the starting switch, run off as much film as is necessary to bring the end of the "Part No." leader approximately up to the projector aperture.

IV. HORN CONTROLS

If the equipment is of the rack-mounted type, with a 200-A output control panel, first adjust the horn controls on the output control panel for the A, B, C settings as required for the particular subject being shown. Then set up the record of film according to the directions. The following table shows the steps on which the horn control dial switches on this panel must be placed to give, respectively, the A, B, and C settings:

"A" SETTINGS

Controls	1	2	3	4	5	6
Steps	. .	. .	. .	. .	. .	.

"B" SETTINGS

Controls	1	2	3	4	5	6
Steps	. .	. .	. .	. .	. .	.

"C" SETTINGS

Controls	1	2	3	4	5	6
Steps	. .	. .	. .	. .	. .	.

V. FADER AND HORN SETTINGS

The full-house fader setting is shown on each record or sound film by a number, 8, 9, 10, etc. The horn setting or grouping recommended for the record of film is indicated by the letter A, B, or C.

The significance of the letters is as follows:

A—For speech, vocal or instrumental solo, with or without light orchestral accompaniment, use the upper

horns only. In very rare cases a relatively small volume from the lower horns may be needed to improve realism. The necessity for the lower horns usually indicates faulty upper-horn distribution, except when the balcony or balconies are high.

B—For a solo or a chorus accompanied by orchestra, use the full upper horns with a relatively medium volume from the lower horns to bring out the accompanying orchestra.

C—For a synchronized score or a heavy orchestra selection, theatres differ. For some theatres and horn locations this setting is best: full upper horns and medium volume from the lower horns. Other theatres sound better with full lower horns and medium upper. Upper horns give brilliance. Lower horns add base. A setting giving equal volume from the uppers and the lowers has also been satisfactory in some theatres.

Short subjects are to be run at a level that will give a natural and agreeable effect. Generally speaking, it is essential to recognize that synchronized accompaniments are a type of music which is incidental to the picture. Therefore, though such music must always be heard clearly and without effort by each member of the audience, it must not be so loud as to obtrude itself on the audience, or to distract attention from the picture. Synchronized accompaniments are for this reason to be run at a comparatively low volume. The fader is intended to be kept generally at the same setting throughout the playing of each subject, although it may be brought up temporarily during storms, fights, etc., if the management desires more volume at these points. It should be remembered that the score has been carefully recorded under the direction of a capable musical conductor and that the finished product has afterward been checked by experts. At the latter time further refinements have been added as indicated by changes in fader settings to be supplied during the running of a record

or film. Usually no fader changes other than those given on the printed "Cue sheet" are needed to secure artistically correct effects. The most frequent fault in the presentation of numbers is that the volume is too high. The realism and articulation of vocal numbers often suffer from excessive loudness.

VI. WAXING FILMS

All sound films are treated at the laboratories by putting a thin layer of paraffin on the edges of the films covering the margins of the sprocket holes. This is done to overcome the tendency of the fresh emulsion on new films to stick or jam in the head of the projector. It is practically impossible for new films to be released from the laboratories for service without this treatment. Since further waxing of new film in the field would result in too heavy a deposit, extreme caution should be exercised to prevent films from being treated by the projectionist if they have already been treated by the laboratories. Whenever new film is not treated and consequently has to be treated locally, only the edges containing the sprocket holes should be waxed. Any material placed on the picture portion will spoil the film.

IX. Instructions for Operating Western Electric Sound Projector System 1-D Equipment

I. LIGHTING UP ROUTINE

Turn on the filament switches A, H, and F.
Turn on the 220 volts A. C. switch.
Turn on the 521-A filament supply and adjust it to read 10 volts.
Turn on the 8-B amplifier filament.
Turn on the 520-A rectifier panel and adjust it to read 12 amps.

All filaments are now burning. Let them burn for five minutes; then turn on the plate current and adjust it for the amplifiers. These are controlled by the voltmeter transfer switch and regulated by the plate controls on the 519-A filter panel and the last control on the 520-A rectifier panel. They are all marked under the stage switches on the 519-A filter panel to show the proper plate current. Next adjust the 8-B amplifier to read as follows:

Plate Current No. 1 tube 0.5 to 10 mils.
Plate Current No. 2 tube 8 to 18 mils.
Plate Current No. 3 tube 16 to 28 mils.
Filament Current No. 1 tube 0.95 amp.
Filament Current No. 2 and 3 tubes 1.55 amp.

These are all tested from your 514-A meter panel. Turn on horn switch.

II. SHUTTING DOWN ROUTINE

Turn off the horn switch.
Turn off the 520-A rectifier panel.
Turn off the 8-B amplifier panel.
Turn off the 521-A filament supply panel.
Turn off the 220-volts A. C. switch.
Turn off the A, H, and F battery switches.

III. STARTING AND TESTING

A. Film Amplifier Equipment

If the film pick-up apparatus is to be used, prepare it for operating, as explained below, before starting up the main amplifier.

It is extremely important to have the exciting lamp on the film pick-up attachment properly adjusted, with the current at the proper value, as will be specified. The object is to obtain a bright, clear illumination of the photo-electric cell. If the light is not properly adjusted, the volume heard

from the horns may be too low or the audition may be poor. Since the vibration of the projector tends to jar the lamps and to cause it to change its position, go over this adjustment every day.

Dust on the lamp and lenses, dirt clogging the openings in the aperture plate and tension pad, or dirt on the film, will also cause insufficient illumination. The film must, therefore, be kept in first-class condition, and the other parts mentioned must be cleaned every day.

After cleaning, as just mentioned, proceed as follows:

1. Close the film pick-up switch mounted on the front wall of the projection room.
2. Put the lamp in the socket and light it by turning the control on the door of the compartment. Adjust the control so that the meter reads 3.6 amperes.
3. Loosen the lamp-socket clamping screw and turn the lamp till the filament is perpendicular to the axis of the lens tube. Then, keeping this adjustment, move the lamp up or down until the filament image is centred vertically on the slit in the lens tube as observed through the window inside of the tube. Tighten the clamping screw.
4. Loosen the screw which clamps the lamp socket holder and the regular distance of the lamp from the lens tube by moving the socket holder endwise until the sharpest possible focus is obtained on the slit. This will also give the brightest illumination on the slit. Tighten the clamping screw.
5. Make a sidewise adjustment of the lamp by releasing the side adjustment clamping screw and turning the side-adjustment knob until the filament image is centred horizontally on the slit. In making this adjustment, when trying to move the bracket away from you, it is necessary to press steadily on the knob at the same time that you turn it, otherwise the bracket will not move. After adjusting, tighten the clamping screw.
6. If making one of these adjustments upsets a previous

adjustment, go back and make the latter again. When all the adjustments are correctly made the filament image will be bright and sharp and perfectly centred on the slit.

7. Turn the control on the film amplifier until the meter pointer is at the middle of the red mark.

After an exciting lamp has been used considerably, the filament may show a tendency to sag. This has a bad effect on the volume, since the filament image no longer coincides with the slit. Another result of aging that tends to cut down the volume is blackening of the lamp bulb, which reduces the amount of light omitted. Therefore, as soon as the filament begins to sag noticeably, or the glass begins to darken, replace the lamp.

On account of the number of operations involved in adjusting the exciting lamp and the possibility that one may have to be replaced during a show, it is necessary to have some means of putting in a new lamp and operating it at a moment's notice. This can be done by setting up in the attachment each spare lamp and bracket supplied, and making all bracket adjustments needed for proper operation. As already explained, the bracket can be slipped bodily off the supporting pins without disturbing any adjustments. The spare lamp and the bracket can, therefore, be removed and stored away ready for immediate use. If possible, keep the lamp in the bracket; otherwise mark each to facilitate identification.

B. Main Amplifier Equipment

When the 41-A, 42-A, or 43-A amplifiers are installed proceed as follows:

1. See that starting switches on the 42-A and 43-A amplifiers are turned off and that the horn safety switch is off. If you are starting up during a show

make sure that the theatre horns are turned off by means of the output control key on the output control panel.

2. See that the storage batteries are switched on ready for use, as explained in the preceding section. See that the power safety switch is closed.
3. On the 42-A and 43-A amplifiers turn the starting switch to "Fil."
4. On the 41-A amplifier see that the filament key is on and adjust the filament control so that the pointer of the filament meter is at the middle of the red mark.
5. On the 42-A and 43-A amplifiers turn the starting switch to "Plate."
6. On the 41-A amplifier press in turn the three buttons marked "Plate Current." The meter marked "Plate" should read, in each case, not less than 1.35 nor more than 1.55 milliamperes.
7. On the 42-A and 43-A amplifiers each meter pointer should be on the red mark.
8. Turn on the horn safety switch.

IV. TYPE 2-SX-41

A. Preparation for Operation

1. See that the gain control dial is set as recommended by the Western Electric engineer. See that all switches are in the "off" position. Proceed as follows:
2. Operating battery panel:
   Set the control switch at "Operate" for the A-1 and H-1 batteries.
   Set the control switch at "Operate" for the F-1 battery.
3. Close the A. C. line amplifier switch.
4. On the 43-A panel turn on the filament-plate switch to read "Fil."
5. On the 42-A panel turn on the filament-plate switch to read "Fil."

6. On the 41-A panel turn on the filament-plate switch to read "Filament Key." Adjust by the filament control dial. It is very important to keep the meter reading at 250 at all times; the tubes in the 43-A and 42-A panel are now warming up, and should be allowed to do so for at least five minutes or more before the plate current is turned on. Otherwise there is a risk of injuring them by a flash over.
7. On the 43-A panel turn on the filament-plate switch to read "Plate." The meter should now read between 100 and 150 milliamperes.
8. On the 42-A panel turn on tne filament-plate switch to read "Plate." The meter should now read between 50 and 65.
9. On the 41-A panel press the button. Numbers 1, 2, and 3 should read 1.5 each.
10. Close the A. C. line—"Horn Switch."
11. On the 200-A output panel set the key at "E," which is down position. You can also use the "R" position, since these two are tied together. Note the "R" position is up. You may be in a hurry sometime and hit this key to the "Off" position; therefore, always set the key to "E" position.
12. Turn on the fader key switch to either "Regular" or "Emergency," since these two are tied together. The fader should be to "Off" position.
13. On the 200-A panel turn on the monitor and theatre horns to be used.
14. For disk, use the switching panel. It should read "Disk," as indicated by pilot light.
15. For film, use the switching panel. It should read "Film," indicated by the pilot light. Close the 6-pole switch mounted on front wall. The current should now be flowing through the exciting lamp and meter adjusted to read 3.6 amps.; also the current for the photo-electric cell and amplifier. The meter should be adjusted to read 250 milliamperes.

B. Shutting Down Equipment

1. On the 200-A panel turn off the monitor and theatre horns; also key from "E" to "Off."
2. Turn off the A. C. line—"Horn Switch."
3. In using the film method pull the 6-pole switch controlling the exciting-lamp photo-electric amplifier.
4. On the fader turn the key to "Off."
5. On the 41-A panel turn the filament key to "Off."
6. On the 42-A panel turn the filament plate switch to "Off."
7. On the 43-A panel turn the filament plate switch to "Off."
8. Turn off A. C. line amplifier switch.
9. Turn off control switches in battery panel A-1, H-1, and F-1.

C. Starting and Testing

1. Starting main amplifier equipment

When the amplifier installed is the 46-A, proceed as follows:

1. See that the horn safety switch is off. If you are starting during a show make sure that the theatre horns are turned off.
2. See that the storage batteries are switched on ready for use, as explained in preceding section. See that the power safety switch is closed. (On D. C. supply, start the motor generator by turning on the motor generator switch.)
3. On the 46-A amplifier turn on the starting switch, and adjust the filament control so that the meter pointer is at the middle of the red mark.
4. Turn on the horn safety switch.

2. Testing amplifier equipment

Having started the amplifier equipment, as already described, test it as follows before every show:

1. If both disk and film equipment are installed switch in whichever is to be tested first by means of the film-disk switching arrangement.
2. Put the pick-up equipment on one machine or turntable in the circuit by setting the fader at point 9 on the side to which this equipment is connected.
3. If you are testing the disk pick-up, rub the needle of the reproducer lightly with the finger. This should be clearly heard in the monitor horn.
4. If you are testing the film pick-up see that the lamp current is at the value previously specified and readjust it if necessary. Take out the light gate by loosening the lever set screw which goes to the photoelectric cell. An oval spot of light will be seen on it. The blurred light should be otherwise clear and uniform. If there seems to be a shadow at one end of spot of light, or at top or bottom, give the lamp further adjustment, sidewise or vertically, as the case may be, until the shadows disappear. Do not change the focus which has already been set. Now move a card up and down across light spot. Every time this is done a click should be heard in the monitor horn. Finally replace the light gate.
5. Move the fader to the other side and test that pick-up equipment in the same way.
6. Bring the fader to "Zero."

3. Shutting down amplifier equipment

With 41-A, 42-A, or 43-A amplifiers, proceed as follows, and always in the order given here:

1. Turn off the horn safety switch.
2. Turn off the starting switches on the 42-A and 43-A amplifiers.
3. Turn off the power safety switch. On D. C. supply, also shut down the motor generator set by turning off the motor switch.
4. Turn off the film pick-up switch on the front wall of

the projection room if the installation is equipped for film reproduction.

5. Turn off the storage batteries at the battery panel.

With a 46-A amplifier proceed as follows and always in the order given here:

1. Turn off the horn safety switch.
2. Turn off the starting switch on the 46-A amplifier.
3. On D. C. supply, turn off the motor generator switch.
4. Turn off the film pick-up switch on the front wall of the projection room if the installation is equipped for film reproduction.
5. Turn off the storage batteries at battery panel.

4. Splicing film—disk reproduction

Vitaphone film has sixteen frames per foot, and each foot is numbered. Beginning with "O" at the starting mark, the sixteenth frame after the starting mark is marked "1." The sixteenth frame after number 1 is marked "2," and so on throughout the print. There are, therefore, fifteen frames without numbers between each pair of numbers. By this system the position of every single frame in the reel is indicated. In synchronized features there are, in addition, other numbers on the margin of the film, which indicate the scene numbers of the picture. These can be distinguished from the footage numbers because they have a dash at each side; for instance, "–286–," the footage numbers themselves being simply "286," without the dash at either end. In cases where the scene and footage numbers conflict the footage number is omitted but is counted, and reference will have to be made to the next footage number in sequence.

If a footage number does not appear at each sixteenth frame continue counting until you reach the next number, when you should have 31 frames between the two footage

numbers. With the numbering system described it is easy to ascertain whether or not a print has the proper number of frames by simply examining each splice and counting the footage numbers on each side. The two numbers should be consecutive, and there should be fifteen frames without numbers between them. In case of a break in a film make a patch by inserting black leader. Be sure that the number of frames of black leader inserted is exactly the same as the number of frames you take out of the film plus the frames used for the patches. After putting in the black leader be sure to check up and see that the numbers follow in sequence and that there are exactly fifteen frames without numbers between each pair of footage numbers. If any numbered frames are missing, or if the missing portion is more than one foot, you will have to check both sides of the break to the next number. After making the splice, see that you do not forget the intervening numbered frames.

5. Splicing film—film reproduction

In case film carrying a sound track becomes broken, cut out as few frames as possible when making the splice. A break in the sound track is usually even more noticeable to the audience than a break in the picture. However, do not go to the extreme of saving weak film that will cause trouble later.

A plain splice, no matter how carefully made, will cause a click to be heard from the sound projectors as it passes through the film-reproducing attachment, because the two edges and the overlap disturb the uniformity of the sound track and produce the same effect as though noises had actually been recorded on the track. In dealing with film of this type, therefore, first make a splice in the usual manner and then paint the splice black. The painted mark on the sound track should be, roughly, triangular in

shape, with a blunted apex, and between $\frac{3}{8}$ inch and $\frac{1}{2}$ inch wide at the base. If the splice is painted in this manner it will be almost inaudible when passing through the reproducing attachment, for the change in the light intensity which it causes will be at a frequency below the audible range. If the mark is made too short the click will be decidedly pronounced. If it is made too long there will be no click but a noticeable pause in the sound, owing to the fact that so much of the sound track has been obliterated.

For opaquing splices, the use of Zapon Concentrated Black Lacquer No. 2002-2 is recommended. It is made by the Zapon Company, Stamford, Connecticut. When a thinner is necessary, Zapon thinner No. 20 is likewise recommended. The lacquer should be applied to the shiny, or celluloid, side of the film and not to the emulsion side. It dries almost instantly, adheres tightly, and is much more satisfactory than India ink or other substances. If for any reason it should become necessary to remove the mark a rag soaked in lacquer thinner will be effective. Splices in the negative in making up subjects sent out by the producers are taken care of in the printing and may be detected by the triangular marks along the sound track near changes of scene.

X. Description of Western Electric Universal Base

This set provides means for synchronous reproduction by both the film and the disk methods and can be employed in conjunction with projection apparatus of several standard makes. Only the lamp and head of the projector are utilized, the base and associated parts being replaced by the reproducer set.

The 1-A base is used to support all the component parts

comprising the 1001-A base. It consists of a cast-iron bed plate supported on four adjustable legs. Mounted upon it are a film reel housing, a start and stop mechanism for the motor, including a switch connected by armoured cable with a fuse box on the edge of the bed plate, and a tilting rod and screw device for adjusting the angle of projection. A grounding lug is also mounted on the edge of the bed plate. Four foot sockets are furnished with this base as loose parts. The legs have ball ends threaded on them, so that very accurate levelling is possible by screwing the ball ends in or out. The starting and stopping mechanism includes a brake which permits rapid stopping of the machine in case of an emergency, such as film break. It is not to be used otherwise, since excessive wear and strain result if it is employed habitually.

There is a sliding connection between the rear of the 703-A bracket and the tilting rod of the 1-A base. The connection is clamped by means of two machine bolts in a piece called the tilting stud. It is intended for making rough adjustments. The tilting rod is threaded at its lower end, where it passes through a nut that can be turned by means of a hand wheel mounted on the bed plate. This provides for accurate adjustment of the projection angle. To meet the needs of houses having two screens, back and front, where the projection angle has to be changed rapidly to suit whichever screen is in use, stop nuts are provided on the threaded part of the tilting rod. Once the stop nuts are locked at the proper points, either projection angle can be obtained by simply turning the hand wheel until its movement is stopped by the upper or lower nut, as the case may be. Projection angles from 0° to 40° may be obtained while keeping the base level. There is a clamping screw operating on a quadrant on the 1-A base. It is needed to steady the upper part of the machine and take up play.

I. I-A SOUND UNIT

This unit is used for film reproduction and consists of a cast-iron chamber divided into three compartments, for the exciting lamp, the film, and the cell. It includes two lamp brackets (one spare), the lens tube and stripper assembly, the film guide mechanism, the rheostat and ammeter for the exciting lamp, a green indicating lamp cap, and fire guard plates.

II. 49-A AMPLIFIER

This is a two-stage transformer-coupled amplifier designed to work between the photo-electric cell and the 701-A apparatus unit. The vacuum tubes are mounted on a vibration-damping suspension to reduce microphonic action to a minimum. There are a rheostat and a milliammeter for the filament current, and two Durham grid leak resistances. This amplifier requires two 239-A vacuum tubes.

III. 700-A APPARATUS UNIT AND CONTROL SWITCH

This unit includes the film-disk switch, serves as a housing for the 49-A amplifier and the 701-A apparatus unit, and contains the interwiring between these units. The operation of the film-disk switch also connects the batteries to the 49-A amplifier and the photo-electric cell and lights the proper one of two indicating lamps mounted on the door of the unit.

IV. LAMP HOUSE ADAPTERS

The lamp house mounting on the 703-A bracket, and the distance between this mounting and the optical centre of a Simplex, Powers, or Motiograph head, when set on this bracket, are the same as on the Motiograph De Luxe Projector. Therefore, if the equipment replaces a Motiograph De Luxe pedestal, no adapter is required. However, if the equipment is to replace a Simplex, a Powers,

or an old-style Motiograph pedestal, a suitable adapter is required and will be shipped with the equipment. Three different types of adapters are used. They correspond to these three makes. If the exhibitor wishes to purchase a new lamp house he should order it equipped to mount on a Motiograph De Luxe pedestal.

V. SLIT ASSEMBLY

Slit assembly in attachment is accurately adjusted and tested. It *must not* be changed. To do so will interfere seriously with the reproduction. The screw clamping the lens barrel will be found to be sealed, and this seal is not to be broken under any circumstances.

VI. SLIT ASSEMBLY ALIGNMENT

Make a check to determine whether the film is running true through the film-reproducing attachment. This may be done by threading up a piece of unexposed negative film in the projector and attachment, with the emulsion side of film toward the lamp. Close the light gate and expose the film by turning on the reproducing lamp for ten seconds, at the same time giving the motor flywheel about two turns by hand. Now examine the band photographed by the image of the slit on the film to see how close it comes to the inner edge of the sprocket holes. This distance should be about .015 inch; if it is less, there is danger that noise may arise from light passing through the sprocket holes; or if it is more, noise may arise from the black line separating the picture from the sound by loosening set screw in the collar on the spindle of the film guide roller just above the reproducing attachment light gate, and by moving the light gate in or out as required. On older designs this collar simply slides; on newer designs it is threaded to facilitate close adjustment. The adjustment should be rechecked by use of the negative film.

Another check is needed to ascertain whether the slit assembly has the proper relation for satisfactory reproduction. Make this check by photographing the slit again as described in the last section, using the same part of the film but with the film turned end for end. Do not move the wheel this time. If the slit is in the correct position images made by this double photographing will be parallel.

XI. Lubrication of Mechanism

The mechanism should be lubricated regularly in the manner now specified. *Avoid lubricating at irregular intervals, and avoid using more lubricant than necessary.* The excess lubricant does not last in the machine any longer than a moderate quantity; it simply runs off, clogs the mechanism, gets on the film, and spoils both the picture and the sound. Use only the lubricants supplied by the manufacturer, or lubricants of approved quality, which have been specially selected for the purpose.

I. LUBRICATION OF UNIVERSAL BASE

A. Driving Side of Machine

Apply one or two drops of light machine oil daily to the following parts: (1) The universal joints on vertical shaft; (2) the oil hole on the upper gear box (the projector-drive gear box, found in Simplex and Powers heads only); (3) the oil cup at the right of the flywheel; (4) the friction disks of the lower magazine take-up. (Turn the magazine reel by hand while doing this, to spread the oil.)

Apply a small amount of graphite grease or vaseline twice a week to the inner side of the driving chain. Once each week clean the take-up friction surfaces by removing the disks and wiping the friction surfaces with a rag soaked in clean oil.

B. Operating Side of Machine

Apply one or two drops of light machine oil daily to the following parts: the lowest guide roller in the projection head; the guide (top) roller in the film compartment; the tension pad idler roller; the top idler of the film chute; the bottom idlers of the film chute; the oil hole behind the sprocket in the lower magazine; the pad roller in the lower magazine; the idler roller in the lower magazine; the oil hole behind the take-up spindle in the lower magazine.

No lubrication by the projectionist is required for any of the equipment beyond that just specified. The motor generator used in case of D. C. supply is also self-lubricating. The service department of the manufacturing company will give the apparatus any periodic care required in the matter of lubrication beyond what has already been directed. In case any oil by accident gets on one of the commutators, wipe it off as soon as possible and clean out the slots between the bars with a wooden toothpick to remove any carbon. Treat the projector head itself as instructed by the manufacturer.

XII. Operation of Tubes

Tubes are specially designed for definite operating conditions. For instance, the filament may be of a 1½, a 3, a 5, or a 10-volt type; and the tube is constructed to permit certain plate and grid voltages, which can be varied within limits. These voltages must correspond to each other in certain proportions and according to the design of the tube. Usually the plate and grid voltages of a tube or a set of tubes in a receiver are fixed, especially in case B-batteries are used; but the filament voltage is variable, being controlled by means of a rheostat.

I. USE OF RHEOSTATS

A rheostat consists of a resistance-wire winding and a movable slider which can be rotated by a knob in order to get any variation of resistance desired. Rheostats are inserted in series with the tubes, so that all the filament current must pass through them. The average person assumes that the rheostat must be operated for volume and therefore tends to advance it too far, permitting too much current to pass through the tubes. This practice, however, shortens the life of the tubes considerably, for when their filament is burned too high they will soon lose their electron-emitting capacity. If a tube has been overloaded by thus burning it too high it can sometimes be restored to its normal operation by reactivation. However, reactivation will not always remedy the condition, and if this is the case the tube must be replaced. Too low a filament temperature, if continued for any length of time, is also injurious to the filament, since it then becomes brittle and may break under vibration.

II. NECESSITY OF PROPER GRID BIASING

By grid biasing is meant the voltage applied to the grid of a tube to hold it either negative or positive. The application makes the tube stable in operation and helps to prevent it from breaking into oscillation. If no separate battery is used for this purpose, the biasing voltage for the grid is obtained from the filament circuit. The exact amount of grid voltage necessary for certain tubes depends to some extent on the amount of voltage applied to the plate. The higher the plate voltage applied to a tube, the higher must be the grid voltage to secure a balanced bias.

It should be remembered that the lower the negative grid voltage on the audio tubes the lower will be the internal impedance of the tube, which is the resistance to the passage of current between the filament and the plate.

A comparatively low impedance in a tube means better tone quality in the receiver. On the other hand, a high grid voltage increases the internal impedance of a tube. If this is excessively high, harsh-toned and distorted sound may result. A high grid voltage means less consumption of plate current; this in turn assures a longer life of the B batteries than may be expected with a low grid bias.

III. ADJUSTING GRID BIAS

The most satisfactory method of adjusting the grid bias is to insert a milliammeter in the plate line of the tube that is to be adjusted. The plate and grid voltages are then adjusted so that when the amplifier is set in operation the needle will not fluctuate. If the needle of the milliammeter reflects toward zero, when the amplifier is in operation, the C batteries on the grid are too high. If it deflects in the opposite direction the C-voltage is too low. If the grid and plate voltages are correct there should be no appreciable fluctuation of the needle when the amplifier is turned on or off. Ordinarily it will be found that the correct use of C-voltage as recommended by the manufacturer will give satisfactory results. However, in order to adjust the C-voltage connect a variable resistance in series with the C-battery, or resistor, and the grid of the tube.

IV. MISCELLANEOUS TUBE DATA

The following tubes are used in Western Electric Amplifiers.

CODE NO. AMPLIFIER	TUBES
8 - B	102–205–205
*9 - A	205–205
*10 - A	211–211
	211–211
41 - A	239–239–239

*Push-pull amplifiers.

CODE NO. AMPLIFIER	TUBES
*42 - A	205–205 ampl.
	205–205 rect.
*43 -	211–211 ampl.
	211–211 rect.
*46 - A and B	239–239–205–205 ampl.
	205–205 rect.

*Push-pull amplifiers.

All tubes depreciate with use; their utility for a given number of hours is estimated under normal operating conditions. Although the average life of tubes is thus estimated, manufacturers do not as a rule guarantee this for any definite length of time; for the use of incorrect voltage and current will shorten the period considerably. It is estimated that the average life of vacuum tubes is about fifteen hundred hours. However, tubes may last much longer than this if they are operated at the given current and voltage recommended by the manufacturer.

Most tubes have thorium-impregnated filaments. When tubes are burned too high the surface layer of the thorium is gradually lost and the emission capacity is greatly decreased. When this occurs the rheostats are usually turned up still higher; and the tubes, thus overloaded, become paralyzed. In most cases paralyzed tubes can be restored to a great extent by a process called reactivation, but sometimes the paralyzed condition cannot be remedied and the tube must be discarded.

Some projectionists make adjustments with screwdrivers or other metal tools to tighten up loose connections, and to adjust condensers, without first disconnecting the batteries and removing the tubes. This procedure is unwise, for the tool may accidentally touch some metal. A short circuit will then result and will allow the high-voltage B-battery current to get on the filament lines. Tubes are often burned out in this way, but sometimes they can still

be lighted afterward. It will be found, in any case, that such exposure has paralyzed them considerably, decreasing the volume of reception or causing total inaudibility. If this has happened, take the tubes out and test them. Most likely they will need reactivation, but in many cases this will not improve their condition. Such accidents can be prevented by disconnecting the B-supply while the adjustments are being made inside the amplifier.

Periodically the tubes of an amplifier should be taken to a neighbourhood radio dealer, who will usually test them without charge. In order to guard against an incorrect report, projectionists should acquaint themselves with the meters used for tube testing and their operation.

XIII. R. C. A.–Photophone Projector System

This system is used with R. C. A. Projectors and can also be installed on Simplex Projectors. The R. C. A. Projector includes the Projector Mechanism, a base, a top, and a lower magazine, an optical system, and a photoelectric cell. A complete projector is furnished with the R. C. A. equipment, less lamp house and projector lens. Motors of special design are used to drive the projector. They maintain a constant speed of 90 R. P. M., which is the standard speed for sound film. These motors may be either A. C. or D. C., to accommodate the service feeds in the projection room of the theatre or studio. R. C. A.-Photophone film is of standard width and is provided with a sound track alongside the photograph upon which music, sound, or speech is recorded.

The optical system mentioned above consists of an exciting lamp, a lens, and a slit tube. The light passes from the exciting lamp through the lens, through the slit tube, and through the sound track to the film. The light rays are gathered by the photo-electric cell; this amount of

light is then transmitted into electric energy and is later amplified and distributed by the loudspeakers. There are two exciting lamps installed in a swinging arrangement, so when one exciting lamp is being used there is always a second exciting lamp ready for auxiliary operation. The lamps may be changed in a moment without a noticeable effect on the sound.

The R. C. A. Projector Mechanism is entirely closed. The revolving shutter is placed between the cooling plate and the aperture of the projector. This arrangement eliminates about 40 per cent. of the usual heat on the film. Greater care must be exercised with recorded sound film, and buckling should always be avoided. Attention to these instructions results in improved pictures, as a result of sharp focus and less buckling. The R. C. A. Projector Mechanism is lubricated with the splash oil system, which provides lubrication for all working parts. The intermittent movement is very easily removed and replaced. Shutter and lens adjustments are provided. The entire gear system of the projector runs in a four-speed oil bath, thereby assuring long life and quiet operation, together with freedom from the annoyances incident to frequent overhauling. The film path is clearly indicated by conspicuous guide lines within the machine to facilitate rapid and accurate threading.

The photo-electric cell unit is inserted when the hinging door is closed, after threading the projector mechanism. The photo-electric cell unit is not provided with a pick-up amplifier similar to other equipments. It is provided with a transformer pick-up, instead of an amplifier pick-up.

1. THREADING THE PROJECTOR

The film, coming from the top magazine, is threaded over the top sprocket and passes over the aperture over the intermittent movement; and thence to the lower sprocket,

over a tension idler over a drum (this keeps the film moving evenly past the slit ray, which is carried to the photoelectric cell), over another spring idler to the lower take-up sprocket, and to the lower take-up reel in the lower magazine.

The projector is very easily threaded. The R. C. A. take-up, which is installed on the R. C. A. Projector, is chain drive and includes two plates, one installed directly over the top of the other. As the film is being taken up on the reel in the lower magazine, the weight increases. The friction against the lower plate, which is driven from the mechanism, causes the take-up to function with a very steady, even pull, which is very easy on the film. In addition to the R. C. A.-Photophone Projector, R. C. A.-Photophone manufactures a special sound head attachment that can be installed on certain standard motion picture projectors.

Two amplifiers are furnished with R. C. A. equipment. One is always kept in reserve in case of emergency. The two voltage amplification stages have one UX-841 tube and two UX-210 tubes. There are connected ten UX-845 tubes in two banks of five push-pull switches in the power amplification stages. Jacks are connected with the amplifier circuits to check the condition of the latter; plugs with cord to plug into the jacks are provided, and two meters are supplied for checking. The left side of the amplifier is confined to the operation of projector A and the projector B is confined to the right side. Three meters, marked "IP Back Tubes," "IP Front Tubes," and "Speaker Current," and one "Charge-Discharge" meter are permanently connected in certain amplifier circuits.

A monitor loudspeaker, which is used as a check upon the output of each amplifier, may be attached to a "Monitor" plug on either amplifier. An important feature of the R. C. A. equipment is that, by the use of special circuits

and groupings of unit parts, the burning out of an individual tube, or even the unusual development of a fault in an amplifier unit, does not stop operation. Either of these emergencies merely modifies the sound without totally interrupting the performance. Thereby the attention of the projectionist is directed to the need for the replacement of a tube, or some other change in operation. Almost all of the R. C. A. Amplifier equipments are open and accessible, allowing for easy replacements of the vacuum tubes when necessary. The vacuum tubes used in all Photophone amplifiers are R. C. A. Radiotrons.

Three types of projection equipment are furnished for theatres having the following type designs and will serve audiences for the following numbers of persons in the average auditorium or theatre:

Type B—up to 5,000 persons
Type C—up to 1,500 persons
Type D—up to 750 persons

The equipment is designed to give spectacular effects when such are called for and therefore has a considerable overload capacity.

II. TWO FOUR-UNIT MOTOR GENERATOR SETS

One of these motor generator sets is connected to each amplifier. One four-unit motor generator supplies the current for one amplifier and consists of one 4-horse-power motor for A. C. power supply at 220 volts, 60 cycles, 3 phase; for D. C. supply, at 125 volts. One 500/1000 volt generator is included to furnish current for the tube filaments and for the mazda lamps used in the optical system. One 250-volt generator furnishes exciting current for the fields of the above generators and energizes the loudspeaker fields. Two type 3XCR Exide Storage Batteries are connected in series and floated across each 15-volt generator

circuit. These batteries function as a filter; that is, to smooth out the supply, across the generator circuit and not as a main source of energy.

A signal system is installed in the projection room and is connected with the signalling stations in the auditorium, so that the observer may increase or decrease the volume as he wishes.

There are twelve loudspeakers furnished with R. C. A. equipment. They are installed in groups of two and are so arranged in each theatre—on the stage, alongside the screen—to give the best results. Cone type speakers are used to give the highest quality of tone value. Troubles in loudspeakers may be located on the loudspeaker sectionalizing panel, located at the bottom of either amplifier. One switch marked "Amp. No. 1" and "Amp. No. 2" is used in changing the connection of the loudspeakers from one amplifier to the other.

Another switch, marked "Cones," in the signal output circuit closes this circuit when turned on, and opens the circuit and places a "dummy" resistance in place of the loudspeaker cones resistance when thrown off. This also enables the projectionist to use the monitor for checking the amplifier output without using the main loudspeakers.

XIV. Operation of R. C. A.–Photophone Sound Projector System

Before operation, the following equipment should be in the proper location as stated below:

NUMBER	MATERIAL	LOCATION
1	UX-841 Radiotron	Second socket in the voltage amplification section of the amplifier
2	UX-210 Radiotron	First and third sockets in the voltage amplification section of the amplifier

NUMBER	MATERIAL	LOCATION
10	UX-845 Radiotron	Ten sockets in the power amplification section of the amplifier
2	PJ-15 Photo-cell	One in the photo-cell housing on each reproducer
4	Projector prefocussed lamps (M-3626287-G2)	Two in the lamp sockets of the optical system housing on each projector reproducer
2	No. 2370 Burgess Battery	Voltage amplification section of the amplifier
1	No. 4156 Burgess Battery	Voltage amplification section of the amplifier

When it is necessary to remove the metal covers on the back of the amplifiers to inspect internal wiring, replace the tubes and the fuses. When work is required on the motor generator set, it is always advisable to shut it down.

I. PROJECTOR AND REPRODUCER PREPARATION

When sound film is being projected it is necessary to mask the sound track. Therefore be sure to have the correct aperture plate in position before starting. Always check the optical system before the projector is started. It is advisable to use a 2,000-foot reel with a hub diameter of five inches for the take-up reel. After threading the projector mechanism, run a few feet of film through to see that the film is tracking properly.

II. PREPARATION OF AMPLIFIER

Make sure both lamp rheostats have all their resistance cut in. Push the "Start" button on the switch marked "Amplifier, Plate and Filament Generator." A red pilot lamp beside this switch will indicate that the motor-generator set is running. Throw the switch marked "Charge Battery." Throw both switches on the input panel to the "On" position. Insert one of the instrument

plugs in the jack marked EC×50 and adjust the field rheostat marked "Bias Generator" until you obtain a reading of 5.

Insert one of the instrument plugs in the jack marked EC×50, and adjust the field rheostat marked "Filament Generator" until you obtain a reading of 6.6. Insert one of the instrument plugs in the jack marked ILB×1 and adjust the lamp rheostat so that a reading between 4.8 and 5.25 is obtained. Insert an instrument plug in the jack marked EB123×100 and adjust the field rheostat marked "Plate Generator" until it reads 5.

When a reading of 5 is obtained, as above, a plug inserted in the jack marked EB4-13×100 will give a reading of 10. Adjust the IP Back Tubes and the IP Front Tubes meter readings to 0.325 by means of the rheostats marked "Back Tubes IP Control" and "Front Tubes IP Control." The charging rate as indicated on the Charge-Discharge meter should be 4 to 7.5 amperes.

Throw the switches marked "LS" and the switch marked "Cones" on the sectionalizing panel to the "On" position, and the switch marked "Amp. No. 1" and "Amp. No. 2" to the correct position, depending upon the amplifier to be used. Plug the monitor loudspeaker in the "Monitor" plug of the amplifier to be used. Set the switches on the projectors marked "Fader" so that the projector that is not starting up is faded in. The projector faded in will be indicated by the red pilot lamp on the input panel.

III. SHOW OPERATION

A. Starting Projector: D. C. Motor Drive

Set the switch marked "Speed Control" to "Normal." See to it that the dial at the end of the drive motor shaft is set to obtain the correct speed as given on the chart

"Dial Settings for Motor Control." Start the projector by snapping the "Line" switch to the "Run" position.

B. A. C. Motor Drive

Start the projector by snapping the "Line" switch to the "On" position.

IV. FADING

Fade in the projector which is to start. When it has come up to speed snap either one of the switches marked "Fader." The red pilot lamp on the input panel will indicate whether or not the machine is faded in.

V. SOUND CHECK

Run up the "Gain Control" on the amplifier to a setting already determined. Listen for the sound from the monitor loudspeaker of the push-the-button switch beside the instrument marked "Speaker Current." A fluctuating reading of the instrument needle should be obtained if the system is operating. If there is no evidence of a signal check the mazda lamp in the optical system and change to the spare lamp if necessary. If there is still no evidence of a signal change to the spare amplifier.

VI. CHANGE-OVER

At the time of the change-over, the projectionist whose machine is finishing should operate the fader switch at the proper time. This process is repeated on all change-overs until the end of the performance.

VII. STOPPING PROJECTORS

A. D. C. Motor Drive

Snap the "Line" switch to either "Brake" position. After the machine stops, snap the "Line" switch to "Off."

B. A. C. Motor Drive

Snap the "Line" switch to "Off."

VIII. SHUTTING DOWN AMPLIFIER

Before shutting down the amplifier at the end of a performance check all meter readings to assure proper operation of the amplifier. To shut down the amplifier proceed as follows: (1) Throw the switch marked "Cones" on the sectionalizing panel to "Off," and run the "Gain Control" to zero; (2) snap the switch marked "Charge Battery" to the "Off" position and adjust "IP Front Tubes" and "IP Back Tubes" meter readings as low as possible, that is, toward zero; (3) cut in all resistance on both lamp rheostats; (4) throw both switches on input panel to the "Off" position; (5) push the "Stop" button on the switch marked "Amplifier Plate and Filament Generator."

IX. PHONOGRAPH OPERATION

A plug marked "Phonograph Pick-up," is provided on the amplifier to plug in the output of a magnetic pick-up type phonograph. The plug is provided so that incidental music may be played as required. Plug the output of the phonograph in the jack; and, with the amplifier in the normal operating condition, regulate the volume by means of the "Gain Control." Do not run a sound film with the phonograph plugged in.

NOTE: *A glossary of technical terms will be found at the end of the book.*

CHAPTER VII

MAINTENANCE AND INSPECTION

I. Introductory

In the broadest sense, operation includes maintenance and inspection; but considerations of convenience to the reader—to say nothing of space or of the magnitude of the entire subject—move me to create the present division. Suffice it to say, then, that the main difference between this chapter and the one before is a matter of emphasis. Here we are concerned with the necessary business of keeping the apparatus in such shape that it may be run dependably.

Since detail is almost forbidding, I have confined my explanations to but two of the various kinds of mechanism —the Western Electric and the R. C. A. systems. In these, however, I believe I have omitted no detail at all. The reason will be apparent to anyone who reads carefully; no detail, in this connection, is a trifle. Consequently I offer a text of reference and a moral. The latter arises from the first and signifies that when a delicate machine is operated to provide subtle effects, the price of success is eternal vigilance. The maintenance and inspection of sound mechanisms demand constant, unremitting care and attention.

II. The Western Electric System

All the information given in this part of the chapter has been based on operating experience gained from a large number of theatres. Those interested should make them-

selves familiar with the findings, in order to insure smooth operation. It is important to remember that, when the sound is not coming over as it should, the fader may be employed to suspend it until the trouble has been located and remedied. It is much better to do this than to continue an accompaniment that is obviously bad. If the fader is manipulated properly, difficulties may be handled by the projectionist with a minimum of audience discomfort. Whenever any trouble occurs use the emergency equipment or emergency set-up if one is provided. Try to locate and remedy the difficulty, if possible, by following the instructions given here.

Replace a burned-out fuse with a new one of the same type. If it blows out a second time, however, do not renew it until the cause of the trouble has been found and remedied. The installation has fuses at various points: reference must be made to the instruction furnished with each equipment, for specific details in this connection.

Before removing the rear cover of any piece of amplifier equipment be sure to turn off the power and to keep it off till the cover is replaced. Likewise throw off the power on the battery switching and charging panel before replacing any fuses.

If, although all conditions are normal, no sound comes from the horns and no relief is afforded by any of the procedures described, a break exists somewhere in the sound circuit. In such case listen in with the headset along the circuit, starting at the disk or film pick-up with a record playing, and working on toward the horns, until the bad spot is located. Be sure to use very little gain, since otherwise the headset will be overloaded and may be damaged, and the quality will be spoiled. Use the same method to locate the source of a foreign noise or any bad tone quality.

Use a battery and buzzer to test lines for opens or shorts, but *never* to test the amplifier or reproducer circuits. To

do so may upset the magnetic characteristics of the coils. On some amplifiers, two or more tubes are operated with filaments in series; if one tube burns out the others will then be extinguished. If two or more tubes go dark at once, therefore, only one may actually be burned out. The dead tube may be located by replacing inspection.

I. DIFFICULTIES DURING TESTING

A. The Charger Fails to Function (A. C. Supply Only)

If a rectifier bulb does not light, its filament may be burned out, or a fuse on the battery panel may have blown out. Clean the tube socket. If the tube still does not light, replace it with one of the spares supplied. If the tubes light but the charger does not give any output, a fuse inside the latter may have been blown out.

B. The Motor Does Not Start

1. Is the line switch on?
2. The fuse in the motor control box may have blown out.

C. The Reading on the Motor Control Box Is Not Within Specified Limits

If the reading is too high on A. C., or too low on D. C., it indicates excessive friction at some point in the mechanism. If this is not attended to immediately a bearing may freeze and render a projector temporarily useless. As soon as an abnormal reading is noted on the meter stop the machine and oil all bearings, particularly any bearing that seems unduly hot. If the trouble persists notify the service man at once.

D. The Motor Does Not Maintain a Regulated Speed

Notify the service engineer at once.

E. There Is an Unsteady Pitch in Reproducing ("Flutter")

With film reproduction there may be dirt on the sprocket in the film compartment of the attachment. If this cause does not exist notify the service engineer at once.

F. The Reproducer Does Not Track Properly

This occurs when the needle jumps from the groove. See that the reproducer is not dragging on the record and that it is not hitting anything or otherwise being hindered from free movement. Put in a new needle. Try a new record. The swivel base on which the reproducer swings is mounted on a bracket, which in turn is clamped to the base by a bolt. See that the bracket is level and that the bolt has not loosened and allowed it to turn.

G. There Is Excessive or Insufficient Plate Current

If this is noticed on testing the amplifiers replace with a spare the tube showing the condition. When two or more tubes on an amplifier all show low plate current at the same time try replacing the rectifier tubes on that amplifier. (The 41-A amplifier uses the rectifier tubes on the 42-A amplifier.) This may also be a sign of defective condensers. (See paragraph I, below, under the heading, "Volume Falls Off or Ceases.")

H. There Is No Sound from One Horn

1. A fuse may have blown out in the cut-out box, backstage.
2. If the fuse in the cut-out box has not blown out replace the receiver.

I. The Volume Falls Off or Ceases

1. If the system is a double one, with an emergency amplifier equipment, cut in the emergency amplifiers by means of a key on the system transfer panel. If this act clears the trouble, continue the use of emergency amplifiers until the service engineer repairs or replaces the defective regular amplifier, unless the trouble can be cleared in the following fashion:
2. One of the amplifier tubes may be burned out. If so, replace it with a new tube of the same type.
3. One horn may have a short circuit in the line or winding through which the sound current passes, thereby

causing the others to receive no power. Turn off all the horns by means of keys on the output control panel. If these are not provided, then shut down by means of switches in the horn cut-out box backstage; then try to locate the bad receiver by turning the horns on and off, one at a time. They should all give volume except the bad one. When the defective receiver is found replace with a spare.

4. Possibly the fuses in the horn supply circuit on the battery panel have blown out.
5. Check the reproducers by switching from one to the other on the fader. If one is bad replace it as described under "Replacements." If neither gives any sound, check the fader and its circuit by means of the head-set or as follows:
6. In systems using 41, 42, and 43 type amplifiers, the left-hand key at the top of the fader (called the fader cut-out key) can be used to cut out either side of the fader circuit. If this key is thrown to the left (red), for example, the reproducing equipment on the "red" machine will be connected directly to the amplifiers without going through the "red" side of the fader. Similarly, when the key is thrown to the right (white) side, the "white" machine is connected directly to the amplifiers. To determine whether the trouble is due to a defect in fader try using the cut-out key in this manner. If this act eliminates trouble, use the cut-out key for change-overs, instead of the fader, until a service engineer can repair or replace the latter. Regulate the volume by means of the gain control on the 41-A amplifier.
7. In film reproduction, the exciting lamp may be out of focus or burned out, or the opening in the photo-electric cell may be out of line with the opening leading to the film compartment. Adjust the cell properly.
8. If the system uses one or more 43-type amplifiers, and the plate current reading on one of these is very

low or is zero, probably a condenser has failed. A further indication of this state is that the plates of the rectifier tubes of the amplifier affected may begin to get red hot. Turn off the power on this amplifier, by means of the amplifier starting switch. Locate the defective condenser as follows:

Remove the front cover of the amplifier. The condensers are connected in parallel in two groups, the first containing C-2 to C-10 inclusive; and the second, C-11 to C-19 inclusive. Unsolder the connection coming from behind the panel to the lower terminal of C-2. Turn the amplifier starting switch to "Plate." If the plate meter reading is now normal it shows that the bad condenser is in the C-2 to C-10 group. Shut off the switch. Restore the connection on C-2 and unsolder the connection between C-2 and C-3. Turn on the switch. If the meter reading is still normal, it shows that C-2 is good and that the bad condenser is in the C-3 to C-10 group. Restore the connection on C-3, and unsolder the connection between C-3 and C-4; test again with the switch and the meter, until a condenser is found which, when connected, causes the meter reading to fall. This one will be the bad condenser. Cut it out by connecting the lower terminals of the two adjoining condensers directly instead of through the lower terminal of the defective condenser. If, in the first place, when the connection coming from behind the panel is unsoldered from the lower terminal of C-2, the meter reading is not brought to normal, the defective condenser is in the C-11 to C-19 group. Then restore the connection on C-2, unsolder the connection between C-11 and C-12, and test for a defective condenser, as already described for the C-2 to C-10 group.

9. If all fuses are in good condition and all current and voltage readings normal, probably there is a ground, open circuit, or a short circuit somewhere in the system. Try to locate the fault with the headset. Possibly

a loose or grounded connection will be found. If so it can easily be repaired.

If the system has no emergency amplifiers, but includes one 43-A amplifier, and this is found to be defective, disconnect its "Input" and "Output" terminals (accessible by removing the back cover) and run the system off the 500-ohm "Output" terminals of the 42-A amplifier. If the system uses two 43-A amplifiers and one is found to be defective disconnect its "Input" and "Output" terminals. When you are cutting out an amplifier as just described, the loss of power can be partly compensated by running the fader higher or raising the "Gain Control" dial on the 41-A amplifier one or two steps. Be careful not to impair the tone quality by raising the fader of the gain so much as to overload the amplifiers.

J. There Is Poor, or Noisy, Quality

1. One of the amplifier or rectifier tubes may be burned out. Replace with a spare of the same type. For amplifier use this must be a new tube.
2. A receiver may be defective. Test the horns one by one, as described in paragraph 3, section I, above.
3. The film may be scratched or dirty.
4. A reproducer may be defective. Test the reproducers as described in paragraph 5, section I, above.
5. A fader may be defective. Check as described in paragraph 6, section I, above.
6. One of the amplifier tubes may be defective. Take a new tube and try it in place of each tube in turn, until the noisy one is located.
7. The storage batteries may be dirty on top. See that they are kept clean, as specified under "Running Storage Batteries." The storage batteries may have been put in use too soon after charging, while still "gassing." About half an hour is required for "gassing" to cease completely.

8. There may be poor ground or loose connection at some point in the system. Examine all connections and tighten any found loose. If the trouble is still unsolved use the headset as described under "Adjustments—General," page 189, and if a defective 43-A amplifier is found, cut it out as described in paragraph 9, section I, above.

K. The Observer's Equipment Is Not Functioning

If the sound is not loud enough to enable the observer and the operator to hear each other, or if the buzzer is weak or inoperative, make sure that the switch on the box is pulled out and that the batteries are in good condition. Replace the batteries. Open the battery box by loosening a screw in the cover. If the trouble is not here check the line for shorts or opens.

II. DIFFICULTIES DURING THE SHOW

A. Film Breaks (Film Reproduction)

Since synchronism between pictures and sound is inherent in the film, no loss of synchronism is occasioned by a break. Therefore handle a broken sound film as you would an ordinary film under the same circumstances; but in making a splice be sure to follow the directions given under "Replacements—Splicing Film."

B. Film Breaks (Disk Reproduction)

Douse the light turn the ader to zero, and stop the motor. The next step, as specified below, will depend on whether the break is above the intermittent or below it, and whether the sound consists only of a musical accompaniment and incidental effects; or of speech, close-ups, etc., which make synchronism very important.

Splice the broken films as described under "Replacements—Splicing Film."

1. Break below intermittents—all cases

Run down the film, needed for winding around the take-up, by means of hand wheel. Do not disturb the film at the

aperture plate, or the record and reproducer. Continue to run, bringing the fader to the regular setting as soon as full speed is reached. Synchronism will usually be maintained under these conditions. However, since the audience will lose some of the subject, it is generally better in the case of short subjects not to wait for restarting as just described, but to continue the performance immediately by showing the next subject, which is set up on the other machine. In the meantime broken film can be repaired and shown again at the conclusion of the number which is running on the other machine. If the break was near the end of the reel it may not be worth while to return to the subject.

2. *Break above, intermittent—with speech or other sound accompaniment, where exact synchronism is essential*

In this case it is not possible to continue on the broken film without losing synchronism. There is therefore no option except to continue the programme with the next reel, which is set up on the other machine, or else to cut out the sound for the remainder of the reel.

3. *Break above intermittent—with music or other sound accompaniment where exact synchronism is not essential*

Rethread and continue as previously described for a break below intermittent. Synchronism is usually lost under these conditions, but this can be tolerated in an emergency, unless there is a direct cue in the record, such as a knock, a voice, or cheers. In such a case pass over the cue with the fader on zero.

C. The Needle Jumps the Groove

If the needle jumps back the sound will repeat, and may keep on repeating at every turn of the record. If the needle jumps forward the sound will be ahead of the picture. The procedure will depend on the character of the film and the place where the jump occurs. Any record on which the needle has jumped must never be used again, and the reproducer should be checked as soon as possible, as covered under "Difficulties During Testing—

Reproducer Not Tracking Properly," page 160. Bring the fader to zero as soon as the jump is noticed. The next procedure will depend on circumstances, as follows:

1. With speech or other sound accompaniment, where exact synchronism is essential

In this case it is not possible to continue without losing synchronism, and there is no option except to continue the programme with next reel, which is set up on the other machine, or else to cut out the sound for the remainder of the reel.

2. With music or other sound accompaniment, where exact synchronism is not essential

Keep the projector running and look over the reproducer quickly to see whether there is any visible cause for a jump, such as the reproducer body's dragging on record, or the reproducer's hitting something that prevents it from moving freely. If so, remove the obstacle or change the reproducer (For instructions see "Reproducers," page 168). This, of course, involves loss of accompaniment for the remainder of the reel.

If no cause of the trouble is evident, but the needle jumps back, change the needle, move the reproducer over to a position two or three grooves ahead of where it was when it jumped, and restore the fader to its regular setting. If the needle jumps forward and seems to be tracking properly, restore the fader to its regular setting.

Synchronism is lost when a record is continued after the needle has jumped. In such cases, if there are any direct cues in the picture, such as knocks, voices, cheers, etc., the fader must be put down to zero when passing over them.

D. The Quality Is Bad or Noisy

E. The Volume Falls Off or Ceases

(See recommendations already made under these headings in a previous section, "Difficulties During Testing," page 159.)

Though projectionists are expected to follow the instructions previously given in handling equipment troubles, and to do simple repair work on the apparatus, such as soldering broken connections, replacing burned-out tubes or burned-out fuses, tightening loose parts, replacing defective parts by other parts supplied or recommended for the purpose, etc., they must *never experiment* with the equipment by changing circuits or substituting coils, condensers, etc., of other types. Further, they should keep all spare parts in a clean, dry place, and be sure that the temperature is not above 80 degrees, for a higher degree causes deterioration of the photo-electric cells.

III. VACUUM TUBES

Vacuum tubes require replacement when any one of the three following conditions occur:

1. When plate currents begin to fall below the minimum values specified earlier in this chapter. This, of course, applies only in cases where a meter is provided on the amplifier for the purpose of checking such currents. When two or more amplifier tubes begin to show low plate current at the same time the fault probably does not lie in them but may be due to the rectifier tubes. Therefore try renewing the latter.
2. When the tube begins to be noisy. This statement applies to amplifier tubes.
3. When the filament shows one or more bright spots instead of glowing uniformly throughout its length.

Tubes that have once been used in a rectifier are unfit for use in amplifiers since they are not capable of giving good quality.

IV. RECEIVERS

If a receiver is found defective by application of the various tests described in these instructions, replace it by

one of the spares furnished. Be sure to connect each wire to the same terminal on the new receiver as on the old one. All four receiver terminals are marked for this purpose. If a receiver is connected wrongly the sound quality will be poor. Never open receivers or attempt to repair them. Never operate a receiver without the horn, for this procedure may damage it.

In installations having only one horn, if such horn is provided with a receiver-switching device, the spare receiver may be put in use by simply moving over the throat lever. The double-throw switch located in the stage cut-out box, which controls the sound circuit to the receivers, must also be thrown to the other position, to connect the spare receiver.

V. REPRODUCERS

If a reproducer is found defective by application of the various tests described in these instructions, replace it by one of the spares furnished. The base of the reproducer assembly (swivel, arm, and reproducer unit) fits on a bracket attached to the turntable pedestal. This base is clamped to the bracket by means of a milled thumbscrew. When the thumbscrew is loosened, and the output leads are disconnected from the connecting block, the whole reproducer assembly can be removed. The simplicity of the operation makes it the best method of changing reproducers quickly.

To change a 4-A reproducer unit remove the two screws attaching the unit to the arm. You will see one of these screws at each side of the reproducer, just behind the head. This act leaves the unit loose except for the output leads. Turn it over on its back and thereby expose the terminal block, and remove the leads by loosening the binding screws that attach them to the terminal block. To put in a new 4-A unit follow these operations in reverse order.

Under no circumstances should anyone open a 4-A reproducer unit or loosen any screws other than those mentioned, for it is filled with a special damping compound. The reproducer will be spoiled if this leaks out. Never attempt to repair or adjust reproducers. Before using a new reproducer during a show test it by playing a record with it or by listening across its terminals with the headset.

VI. PHOTO-ELECTRIC CELLS

To insure correct position and connections for the photo-electric cell be sure that the window in the cell lining is properly adjusted to the opening in the partition separating the cell compartment and the film compartment.

VII. STORAGE BATTERIES

A. Storage Batteries, Attaching Leads to Terminals

On most storage batteries made for sound installation binding posts are provided to facilitate the attaching of the wires. Since the terminals are of lead, a very soft metal, markings are very easily effaced. Frequently, after a battery has been in use for some time, it is difficult to determine the positive terminals from the negative. Most batteries, moreover, have polarity indications. At times a lead becomes loose and fails to make proper contact with the terminal, or both are so corroded that their markings cannot be seen. It is therefore necessary to use some independent method of determining the polarity. If traces of corrosion are indicated on the terminals, the one having a green-coloured corrosion is positive, and the one having a white or gray corrosion is negative. Another method is to apply a suitable voltmeter to the terminals. The leads from the voltmeter are usually marked positive or negative; or else one lead may be red and thus indicate positive polarity. If the needle of the voltmeter deflects toward the

highest reading, the leads of the instrument are touching battery terminals of the same polarity. If the needle deflects away from zero and below the scale, the leads on the voltmeter are touching battery terminals of the opposite polarity. If no voltmeter is available, a simple test can be made in a glass of saturated salt-water solution. Connect two wires to the terminals of the battery, scrape the ends of the wires clean, and immerse them in the salt water, holding the ends about a half inch apart. Be careful not to touch them together. If the battery is in a well-charged condition, the formation of small bubbles at the ends of both wires will be observed. The wire around which the most bubbles collect is the negative one. This method of testing polarity can also be used in case of D. C. lighting-circuit wires. Another simple method of determining the polarity of the battery terminals is to connect two leads as explained above and to insert the bare end in the pulp of a raw potato. The ends of the wires should be stuck into the potato about a half inch apart. In a minute or so the gradual formation of a green spot in the potato will be observed around one of the wires. This wire is positive.

B. Internal Construction of Storage Batteries

A storage battery consists of three individual units or cells, each capable of delivering approximately two volts of electrical pressure and a considerable current or amperage. The cells are connected in series, so that a total potential of six volts or slightly more can be obtained from the battery terminals. Each cell consists of a number of alternate brown and gray-coloured plates, which are made of a lead-alloy framework or grid, holding a hardened paste. The brown plates are positive, with a paste of peroxide of lead; the gray plates are negative, with a paste of sponge or pure lead. All the positive plates in each

cell are connected; similarly, all the negative plates, making two sets. Each plate is separated from the adjacent one of opposite polarity by means of a wood or hard-rubber insulator. The whole plate assembly is set in a jar of glass or hard rubber, or some other acid-resisting material. The top of the jar is sealed shut, with the exception of a small vent hole into which a cap screws. The terminal of each set of plates projects above the cell; and both sets are connected to terminals of opposite polarity on the adjacent cells. A solution of sulphuric acid and pure water is poured into each cell. A five-to-one solution of sulphuric acid and distilled water is customarily used as an electrolyte for storage batteries. The three cells of a 6-volt storage battery are set side by side in a heavier box, which protects them against injury.

C. Testing Storage Batteries with the Hydrometer

As a storage battery discharges and loses its energy, there is a corresponding fall in the specific gravity of the acid; that is, the weight of the acid corresponds with the weight of an equal volume of pure distilled water. Knowing this, it is possible to tell at once whether or not it needs recharging. The hydrometer is an instrument for ascertaining the specific or battery gravity of the acid in a battery.

D. Battery Charging

The most important thing in the care of a storage battery is to keep it properly charged, for it can easily be ruined by neglect in this respect.

The fact that a storage battery gives a fairly good voltage is no guarantee that it does not need recharging, for the voltage may not fall much until well after the danger point of discharge is passed. A better indication of the fitness of the battery for use is the amount of electricity it has discharged, represented by the average rate of dis-

charge in amperes multiplied by the total time of discharge in hours. However, this cannot be reliably measured in practice without the use of rather expensive recording instruments. By far the simplest and best method, and one used universally, is to measure the specific gravity of the battery electrolyte by means of a hydrometer. The electrolyte is the liquid with which the battery is filled by the maker. It consists of a mixture of sulphuric acid and water. The acid makes it heavier than pure water, and the ratio of the weight of a certain volume of the liquid to the weight of the same volume of water is called the specific gravity. When the battery is fully charged the specific gravity (usually called simply "the gravity") is a maximum, ranging somewhere around 1200 or 1300 (assuming water as 1000), depending on the make and type of battery. As the battery is discharged, the gravity falls, because some of the sulphuric acid in the electrolyte combines with the battery plates. Thus, by knowing the gravity, it is possible to tell exactly how much the battery is discharged. The hydrometer is used for this purpose. It is simply a syringe with a rubber bulb and tubular glass nozzle; the latter contains a little glass float with graduations on it. When enough electrolyte to lift the float is drawn out of the battery into the glass nozzle, then if the latter be held vertical the buoyancy of the float will depend on the gravity of the liquid—the higher the gravity, the higher the float will stand above the surface. The reading on the graduated scale at the point where it emerges above the liquid is the specific gravity.

One cell in every group of batteries should be selected as a pilot cell, and the gravity in this cell should be read *every day the equipment is in use.* As soon as the gravity gets down to the point specified in the operating instructions, representing half discharge, that battery group must

be put on charge and kept charging until the pilot cell gravity reaches the value specified in the instructions, or ceases to rise any further. Charging beyond this stage is harmful. For information as to exactly what procedure to follow in switching the batteries on charge, reference must be made to the manufacturer's instructions applying to the particular type of equipment involved. The daily gravity readings should be carefully entered on the battery log sheet supplied, as this information is necessary for the guidance of the service engineer.

Never measure the gravity just after adding water, but wait until the battery has been on charge long enough to stir up the solution.

When the equipment is not being used very much, the battery gravity may not fall to the charging point in a whole month. At such times the batteries are to be charged every month.

A different pilot cell should be selected every month, so that all cells will be used in turn and loss of electrolyte through dripping, etc., will be equalized. All liquid withdrawn from a cell to make a hydrometer reading must be returned to it.

The rheostat or other means for controlling the battery charging rate is set at the correct value by the service engineer, and should not be changed except on his advice. The rate is usually made such that the battery can be charged in about the same time it takes to discharge.

Water

Never put anything into a storage battery except clean *distilled* water. Keep this water in glass or earthenware receptacles, never metal ones.

Battery makers put a certain amount of acid, diluted with water, into each cell when new, and no more acid is

needed. As the water evaporates it must be replaced from time to time so that the solution keeps the plates completely covered.

Every week, on the pilot cell, and *every two weeks* on all the other cells, look at the acid level. To do this, remove the caps and use a flashlight to illuminate the cell interior. The acid level should be about a quarter of an inch above the top of the plates. It should never be allowed to get down to the top of the plates, and on the other hand it should not touch the bottom end of the filling tube.

Add the necessary amount of water by running it in slowly just *before* charging. Batteries require more water in hot weather than in cold weather.

Distilled water may be obtained at any drug store or battery service station. It is best to buy it in large bottles of one gallon to five gallons capacity, and fill the cells either directly from the bottle through a rubber tube, or else by a special filling cup. Do not use a hydrometer for this purpose. If you are not already provided with such an arrangement, our service man will show you how to set up a distilled water bottle with glass tubing and rubber hose.

Cleanliness

Keep the outside of the battery dry and clean, not merely for the sake of appearance, but to obtain proper service.

If you are careless in using the hydrometer, and drip acid on the batteries, or if you leave the filling caps off and allow the fine acid spray, coming from the batteries when they are charging, to be deposited on the battery tops, you invite short circuits and noise in operation. A little acid mixed with dust from the air in the room will soon form an electrical leakage path on the battery top between terminals, which may give a lot of trouble. In any case, once each week clean the battery tops and connectors with a rag moistened in a solution of baking soda in water, or a

solution of household ammonia and water in equal parts. Draw the rag under the connecting bars, so as to be sure of reaching all parts. Scrape off any deposit that may have formed. Be sure none of the cleaning solution gets inside the batteries, so for the sake of safety dampen the cloth somewhere away from the batteries, and do not have it wet enough to drip. After this cleaning wipe off the battery tops with a rag dampened in water; then dry them off with a clean rag. Finally, coat the battery terminals and connecting bars with the special non-oxide grease supplied.

Remember that even a very small particle of dirt getting into a cell may reduce its efficiency and its life. Therefore, *always keep the filling caps screwed on tight*, except when testing the gravity or adding water. The little vent holes in the caps will take care of the gas given off in charging. See that they are clear.

Miscellaneous

If the battery has reached the point where it needs charging, do not let it stand uncharged for more than a day. Connections must be tight at all times. Occasionally check both the outside connections and the cross straps between cells, to insure that they are tight and good connection is being made.

Do not use the batteries right after charging, but allow about half an hour to elapse; otherwise the batteries will still be gassing and this will cause noises to be heard in the system.

Responsibility for Batteries

To insure proper care of the storage batteries, one person should be given full responsibility for them and should fill out the Battery Log Sheet; no one else should touch them.

E. Harmful Effect of Impure Water in Storage Batteries

Water from the city mains, or rain water caught in metal pans, or water containing any minerals or salts, should never be used for storage batteries. Such water contains a substance which is injurious. City water running through metal pipes, and water held in a metal container, absorb some particles of the metal. When such water is used in a battery a slight coating of metal is deposited on the plates and decreases their efficiency. Water containing salt and minerals has the same effect. Pure rain water may be used, provided it is caught in the open, in non-metallic containers.

Distilled water is the safest to use, and may be purchased at any drug store or water company for a few cents per gallon. It should be kept in a glass or porcelain bottle or container and should never be poured into a metal pan or dish when fed to the battery. It is convenient to use a small rubber syringe in feeding the water to the battery. The hydrometer should never be used for a syringe to fill the battery with water, since the float may break from the jarring it receives under such usage. Too much water is likewise undesirable, for when the battery is being charged the electrolyte gets warm and expands and may cause the battery to run over and cause damage.

F. Danger of Explosion

When you are inspecting the battery to see whether or not it contains enough electrolyte, never hold a lighted match over the vent holes of the cells. A serious explosion may result. When a battery is charging, hydrogen gas is liberated, especially at the end of the charge. The gas fills the space in the cells above the electrolyte and is highly inflammable. A flashlight or an electric lamp on an extension cord should always be used—not a match!

G. General Maintenance of Storage Batteries

Storage batteries should be serviced by a battery service station once a year for cleaning and examination. Because of constant charging and discharging a considerable waste is loosened from the plates. It settles at the bottom of the cells and must be removed. It may cause a short circuit inside of a cell unless the battery is designed so that there is enough space at the bottom to hold the accumulation under the plates. The insulators between the plates must similarly be replaced occasionally, and there may be broken plates which should require renewal. Such a sulphated condition can be determined only when the battery is taken apart and examined.

H. Freezing the Battery

A battery that is well charged will not freeze until a temperature of 96 degrees below zero is reached; therefore low temperatures are not especially harmful to charged storage batteries. However, when a battery is discharged and the specific gravity falls to 1025 on the hydrometer, the electrolyte will freeze at a temperature of 30 degrees above zero. Freezing usually spoils the battery.

I. Overheating the Battery

Overheating of a battery may be caused by too heavy a rate of charging, by insufficient electrolyte, or by internal short circuits in the cells. The plates become buckled or broken and may in turn cause the insulators to break, permitting adjacent plates to touch each other and to cause a short circuit. Besides warping the plates, overheating may cause the material on the plates to shed and drop away from the grids. Furthermore, overheating raises the temperature of the electrolyte. There results an excessive sulphation of the plates; and the electrolyte, evaporating quickly, brings about a low level.

J. Life of Storage Batteries

The life of a storage battery depends on the number of times it is charged and discharged. If the battery is used every day for six or eight hours, the battery will have to be recharged more frequently than one used only one or two hours a day at the same rate of discharge. The thickness of the battery plates determines the number of times they may be recharged; the positive plates are twice as thick as the negative. Storage batteries in motor cars have an average life of two years. Radio storage batteries, which are not subjected to nearly such hard usage, last from four to eight years with proper care.

K. Fixed and Variable Resistors of High Values in Amplifier Circuits

Increasing use is made of high-resistance units of both the fixed and the variable types. Resistance-coupled amplifiers are popular because of their tone quality; furthermore, resistance-coupling has been highly satisfactory for audio-frequency amplification. With proper by-passing and balancing, resistors can be used for coupling between intermediate stages.

Trouble may be experienced from faulty resistors. It is therefore wise to obtain the very best quality. Most fixed resistors consist of a glass tube, with metal end caps, containing the resistance element, which is securely connected to the end caps. If the connection is broken the resistor is useless. Many resistors, furthermore, are inclined to be noisy owing to changes in the resistance element, which is affected by atmospheric and temperature conditions. Some manufacturers accordingly produce resistors with resistance element impregnated in the glass. Resistors made this way are claimed to be superior to the common type, since they are more stable in their operation. It is a good precaution to keep an extra set of fixed

resistors on hand to substitute for those in the receiver, in case the latter are defective. When you are replacing resistors be sure to get the same value as that of the defective one, or trouble may result.

L. Fixed-Condenser Difficulties in Amplifier Circuits

Good fixed condensers consist of two sets of thin plates insulated from each other by thin sheets of mica. Poor quality fixed condensers often have only waxed paper for insulation. To prevent moisture from getting inside and causing losses, some fixed condensers are sealed in airtight cases or shells.

The troubles experienced with fixed condensers are open circuits and short circuits, usually the latter. This is caused by excessive voltage, which punctures the insulation and provides a path for current across the plates; or by damaging the insulation by the application of heat, as, for instance, from a soldering iron. For this reason care should be exercised when soldering leads to condenser terminals, so that the parts are not overheated.

M. Testing Fixed Condensers

The condensers should be removed from the amplifier, so that there will be no shunt path around them, which would give a faulty test. The condenser is first completely discharged by holding a wire or a piece of metal across its two terminals. This step will prevent an erratic test caused by a residual charge. The two tips of the head-phone tester, with a C battery connected in series, are then touched to the condenser terminals. There will be a click resulting from the sudden formation of a charge on the condenser plates and the accompanying rush of current through the head phones. One of the testing tips is tapped on the same condenser terminal several times. Sharp clicks should not be heard after the first, and no click should be heard

when the testing tip is removed from the terminal. A double click obtained when the tip is applied and when it is removed indicates a short circuit.

A condenser may be faulty even though it does not show a direct short circuit. Moisture in the insulation may cause a slow leakage and make the condenser worthless for use in an amplifier. The ability of a condenser to hold a charge can also be tested. First discharge the condenser completely and lay it on a piece of glass, mica, bakelite, or other insulating material. Charge it by holding the two leads from a C battery or a B battery to its terminals for a moment. After waiting for two or three minutes, touch both terminals with the testing tips of a headset disconnected from the battery. If a strong click is heard the condenser has retained the charge; but if a weak click is heard, or none at all, the condenser is leaky. The strength of the click of a condenser depends to a great extent on its size. When testing a condenser care must be taken not to touch the terminals of the condenser or the bare tester tips with the fingers. The contact permits a loss through the body of the tester and results in a faulty examination.

N. Faulty Instruments in Amplifiers

Troubles in the amplifier usually manifest themselves in the individual instruments. The projectionist should therefore acquaint himself with the action of the instruments—how to operate them properly, how to maintain them in order to prevent trouble, and in case of trouble, how to remedy it.

O. Audio-Frequency Transformer Construction and Operation

The oldest form of coupling between tubes is transformer coupling. A transformer consists of two coils, a primary and a secondary. The current in the primary wind-

ing induces a stronger current in the secondary by electromagnetic induction, which is concentrated in the core, which is made of an iron or an alloy containing iron. This set-up of voltage depends entirely on the number of turns in the windings. If the secondary has twice as many turns as the primary, the voltage will be doubled; if three times, the voltage will be tripled, etc. The ratio between the primary and secondary windings of audio transformers varies; the 1 to 2, 1 to 3 or $3\frac{1}{2}$ and 1 to 5 or 6 ratios are the commonest. Unless properly designed, transformers may cause considerable distortion of music and speech, and a transformer of poor design may be totally unable to reproduce low-frequency signals. The inadequacy is due to the fact that a transformer usually works better at one frequency than at another, although some manufacturers claim that their transformers have various points of resonance to the frequency on which these transformers operate best, and that this variation makes for more even amplification. Audio-frequencies range from 20 to 10,000 vibrations per second; so the best transformer is one which amplifies more or less uniformly over the entire range. More uniform amplification can be obtained from many transformers by connecting a variable resistance unit having a range of from zero to five megohms across the secondary terminals.

P. Transformer Distortion

In an ideal transformer the fluctuations between the input and output currents would be practically in perfect synchronism. However, in most actual transformers such action is impossible, owing to the reluctance of the core in transferring the energy. The result is a peculiar "lag" effect, particularly noticeable in cheap transformers which have poor core material and are not properly designed. The lag is characterized by the overlapping of one note into the

next. Incorrect core value and material also give rise to distortion and harsh-toned reception. Distortion in transformers can sometimes be traced to leakage because of saturated insulation, coupling effects from other transformers, grounded secondary windings, and incorrect ratios of the windings. Moisture in the windings permits a loss of energy which may develop a short circuit. Saturated coils often cause hissing and frying sounds in the loudspeaker or phones. Coupling effects between transformers are often in evidence where the transformers are of the open type and have no case or shell, or are located close to each other.

Q. Open Circuits and Short Circuits in Transformers Connected in Amplifier Circuits

Transformers may be tested for open circuits, short circuits, and grounds by using the headset tester, which connects a 22½-volt B battery in series with the phones. The testing tips are first applied across the primary terminals. A sharp click should be heard; this shows that there is continuity in the winding. The same test is applied across the secondary terminals. It must be remembered that the click across the secondary terminals will be weaker than that across the primary terminals, because of the greater resistance of the secondary winding. If no click is heard the winding is broken or open-circuited.

A test should also be made to determine whether or not there is any leakage from one winding to another. When you are making this test, be careful to prevent the testing tips from touching each other. The tips should be held immovably to one of the primary binding posts and one of the secondary binding posts. Be sure not to rub them on the posts, for you may thus bring about an incorrect test. In case a click is heard, both when the contact is made and also when it is broken, there is leakage between the

primary and the secondary windings. If a click is heard only when the contact is made the transformer is not leaky, since such a sound is caused by the momentary change of charge in the windings and the accompanying rush of current through the phones.

Short circuits between the windings of a transformer may result from contact of the internal leads and the lugs. A grounded condition may be caused if these leads touch the transformer shell. Such trouble is usually brought about by the loosening of the locknuts on the terminal screws, permitting movement of the leads. Most well-made transformers do not develop such trouble, since the internal leads are well insulated. A complete short circuit of the B battery may result if there is a direct path for current to flow across the primary and secondary windings. To test for such a condition, touch one of the testing tips successively to the shell of the transformer and the other to the terminals; when they are in proper condition no click should be heard; a distinct click indicates a short circuit. The trouble can usually be remedied by removing the shell and providing insulation on the leads. A similar trouble is experienced when the soldering lugs, attached to the terminals on the outside, are accidentally bent down so that they make contact with the shell.

III. R. C. A. Sound-Projector Systems

To insure proper operation the projectionist should inspect and check the equipment (daily and weekly) as follows:

1. DAILY INSPECTION AND CHECK

A. Projector and Reproducer

The projection machine should be given the usual attention. All rollers and friction wheels in the reproducer head must be cleaned twice a day, by means of a lintless

cloth, such as linen saturated with carbon-tetrachloride. It is best to turn the machine by hand while doing this.

B. Optical System

Two special 10-volt, 5-ampere prefocussed lamps are used in each optical system. Before each show these lamps should be inspected. Any one that shows evidence of a sagging filament or discolouration should be replaced with a new one. Both lamps must be checked, since one of these is a spare to be thrown into position should the other fail. Do not replace an old lamp while still hot, since the hot lamp may loosen the bulb. With the lamp in good condition a clear image of the main section of the lamp filament should be seen on a white card held vertically in the hollow of the drum in the sound head.

To compensate for difference in volume between the two projectors run the same short test reel of sound film through each projector. With the amplifier in normal operating condition adjust the lamp current (1LAX1 or 1LBX1) of each projector so that the output voltage of the amplifier, as measured on the meter marked "Special Current," is the same when either machine is run.

The lamp current for each optical system is dependent upon the sensitivity of the photo-cell for the particular machine and should be between the limits of 4.8 to 5.25 amperes. If the difference in volume cannot be adjusted make a compensation test, as described, with spare photo-cells, matching the volume of different combinations of cells.

C. Amplifier

Start the amplifier, using the procedure given under "Operation-Amplifier Preparation," and check the meter readings with those given in the Meter Reading Table.

D. Loudspeakers

The daily check may be obtained in the following manner: With the amplifier in normal operating condition, with all switches on the sectionalizing panel in "Off"

position, and the photo-cell door closed, cut the light to the photo-cell by passing a cardboard punched with several $\frac{1}{16}$-inch holes, between the mazda lamp and the lens barrel in the optical system. Plug in the monitor loudspeaker and listen for a series of "plunks" during the test. Throw switches "LS" and "Cones" on sectionalizing panel to "Qn" and switch "Amp. No. 1" and "Amp. No. 2" to correct position. Listen for series of "plunks" in auditorium loudspeakers when making the test.

A more complete check may be obtained by running a reel of sound and listening to the monitor and auditorium loudspeakers individually, as described above.

E. Storage Batteries

The specific gravity of each storage battery should be measured before each show.

Specific gravity full charged	1275
Specific gravity half charged	1225
Specific gravity discharged	1180

II. WEEKLY INSPECTION AND CHECK

A. Projector and Reproducer

The machine speed should be checked, if a D. C. motor is used, and the dial at the end of the motor shaft set to the corrected calibration as given under "Dial Settings for Motor Control." If an A. C. motor is used the speed will be constant and will require no adjustment.

B. Optical System

Lamp connections on the optical system should be inspected once each week.

C. Amplifier

Make careful inspection of all wiring and connections.

D. Loudspeakers

Make tests with a short reel of sound film as follows:

1. With an amplifier in normal operation condition, and

with all switches on the sectionalizing panel in "Off" position, listen to the monitor loudspeaker.

2. Throw switch marked "Amp. No. 1" and "Amp. No. 2" on the sectionalizing panel to the position marked for the particular amplifier being checked.
3. Throw the switch marked "Cones" to "On" position.
4. Snap switch "LS No. 1" on and listen. If no sound is heard, check the circuit to the loudspeaker fields as explained under "Adjustments—Loudspeakers."
   Check the loudspeaker cone circuits for short circuits as per "Adjustments—Loudspeakers," page 191.
   If rattling noises, distortion, and other objectionable features are present, follow the procedure given under "Adjustments—Loudspeakers" for checking.
5. After the "LS No. 1" group of loudspeakers has been tested, snap switch "LS No. 1" to "Off" position, snap "LS No. 2" switch to "On," and test the second group of loudspeakers in the same manner.
6. Follow this procedure in testing all of the groups of loudspeakers.
7. At the end of this series of individual tests the six groups of loudspeakers should be tested as a unit by snapping all of the "LS" switches to "On" position, running "Gain Control" up to 40, and listening for rattling or other objectionable conditions.

III. ADJUSTMENTS

The following information will assist the projectionist in obtaining proper performance from the reproducer:

A. Projectors

Use a standard projector oil on all roller bearings. Keep the gear bases on all projectors using the A. C. motor drive well oiled. Keep all belts free from oil, inspect them periodically, and wipe with a clean cloth. Also, inspect take-up belts for stretch. This is rectified by removing a small section of belt and relocating the hole for the wire clip. If a projector using the D. C. motor drive is slow to

pick up speed on starting, the tension on the main drive belt may be corrected by loosening the two locking screws on the motor base and dropping this base until the required tension is obtained. Care should be taken not to increase the tension abnormally, for this will result in putting undue strain on the belt.

If, after a projector is started, the take-up lags, causing a looseness which the reel takes up with a snap, then the take-up tension nut on the end of the take-up shaft should be adjusted. Do not run a machine without the film in place. Doing this to any extent may cause flat spots on the drum friction roller.

B. Optical System

The focus of the optical system and the adjustment of the lamp holder have been determined and set at the factory; therefore no further adjustment should be made other than the replacement of the 10-volt prefocussed lamps.

Care should be taken to see that the "eye" of the photocell is at all times lined up properly with the hole in the housing or shell.

C. Amplifier Fuses

All fuses are located on the rear of the amplifier, and their location is indicated on the panel. With the exception of the "Loudspeaker Fields" and "15-volt Generator" fuses, the fuse in any circuit may be checked by the meter reading obtained from the jack in that circuit. The fuses, together with ratings, jacks, and corresponding circuits, are given below:

FUSE MARKING	FUSE RATING	JACK	CIRCUIT
"Battery"	250V-60A	EA×2	Filaments of all tubes; plate voltage; voltage amplifier
"500 volts"	600V-1.8A	EB123×100	
"1000 volts"	2300V-1.3A	EB4-13×100	Plate voltage Power amplifier

FUSE MARKING	FUSE RATING	JACK	CIRCUIT
"Bias"	250V-20″	EC×50	Bias voltage Power amplifier
"Loudspeaker Fields"	250V-1A		Loudspeaker Field
"15-volt Generator"	250V-60A		Positive line; 15-volt generator

Failure of the fuses marked "Loudspeaker Fields" will be indicated by no sound in the auditorium loudspeakers.

If the fuse marked "15-volt Generator" fails, the "Charge-Discharge" ammeter will indicate a discharge reading of about 35 amperes.

If a fuse fails, do not attempt to replace it with a new one until the cause for the failure has been determined.

In case a new fuse does not cure the trouble be sure to check the fuses on the panel board at the motor-generator set.

D. C Batteries

If the grid voltage as measured on the EC12×1 or the EC3×5 jack falls below the minimum value given in the Meter Reading Table, the batteries should be replaced. The batteries used are two $4\frac{1}{2}$ volt Burgess No. 2370 and one $22\frac{1}{2}$-volt No. 4156, all connected in series, as shown in T-3870180, included in envelope in the back cover of book supplied by the manufacturers. Be sure the connections on the C batteries are clean and tight, and keep a spare set of batteries on hand for replacement.

E. Voltage Amplifier Tubes

If the plate current readings (IP1×1, IP2×1, or IP3×5) for any one of the three tubes is abnormal, check the grid voltage (EC12×1 or EC3×5) for this particular tube. (See Meter Reading Table, page 193.) If the grid voltage is correct and the plate current readings for the other two

tubes are correct, replace this tube with a new one. Should the plate reading for any tube be zero, check the plate and filament circuits of the particular tube for loose connections. If the connections are all right put in a new tube. If the plate current of all the tubes is zero, check the fuses marked "Battery" and "500 Volts."

F. Power Amplifier Tubes

The plate current of the ten UX-845 tubes should indicate 0.325 amperes on the two meters marked "IP Back Tubes" and "IP Front Tubes." If the plate current becomes abnormal and the rheostats marked "Back Tubes IP Control" and "Front Tubes IP Control" have not been changed (this may happen accidentally), check the bias voltage (see the Meter Reading Table, page 193) and the grid circuit for loose connections. Abnormal readings may also be caused by the fact that the plate of a tube becomes highly heated. If this condition is noticed shut down the motor generator set and replace the defective tube with a new one. If abnormal readings are still obtained use the spare amplifier and consult an R. C. A.-Photophone service representative. If the plate current for any one bank of tubes is zero and the tube filaments are lighted, check the fuse marked "1000 Volts." When the plate current for any one bank of tubes is zero check the wiring for this circuit.

G. General

If the amplifier does not function and the meter readings obtained are normal, the photo-cell cable should be checked for broken connections. Try a spare photo-cell.

If no sound is obtained, shut down the motor generator set, remove the cover from the input section of the amplifier, and inspect the switch to see whether it closes properly and whether proper contact is made. Check the fader relay for operation, and also the contact points.

Inspect the connections on the photo-cell transformer in the input panel.

H. Motor Generator Set

Instructions for the motor generator set are given in the following:

1000-volt generator	G E H—305B
350-volt generator	G E H—655A
15-volt generator	G E H—655A
Induction driving motor	G E H—189B
D. C. driving motor	G E H—5A
Magnetic starting switch (A. C. motor)	G E H—130A
Magnetic starting switch (D. C. motor)	G E H—144A

Too much care cannot be taken in seeing that the brush fit on the generators is good and that no sparking is present. Any sparking or poor brush contact will result in poor quality and "sputtering" in the loudspeakers. The 250-volt generator furnishes all exciting current for the motor-generator set, and "fluttering" or failure of the voltages to the amplifier may be caused by the "fluttering" or failure of the exciting current.

I. Storage Batteries

The batteries are floated across the 15-volt generator. The current used is supplied by the generator; therefore the gravity of the batteries should indicate a full charge at all times. The charging rate should be 4 to 7.5 amperes, as indicated on the "Charge-Discharge" meter of the amplifier. Be sure battery connections are kept clean and tight. Any corrosion on the terminals should be removed by washing with household ammonia. Vaseline on the terminals will tend to prevent corrosion.

Keep the tops of the batteries clean and keep all tools, etc., off the tops of the batteries to avoid short circuits. If the storage batteries fail to operate satisfactorily consult an R. C. A.-Photophone service representative.

J. Loudspeakers

Failure to operate, rattling, and similar objectionable noises may be localized to a group of two loudspeakers by use of the sectionalizing panel as described under "Weekly Inspection and Check," page 185.

If the sound fails in one or all of the auditorium loudspeakers when the signal is evident in the monitor loudspeaker, check:

1. Loudspeaker field supply

Remove cover from the sectionalizing panel and test the voltage across terminals F1 and F2 on the sectionalizing panel with a 250-volt test lamp. In case no voltage is evident, check the fuses marked "Loudspeaker Field." If these fuses are all right, check the meter reading from the jack EC×50. If no voltage can be measured here, the trouble is probably in the motor-generator set. (See "Motor-Generator—Adjustments," page 190.) When the voltage at the above points is good test the voltage at each group of loudspeakers. If there is no evidence of trouble here check the signal circuit.

2. Signal circuit

If all the loudspeakers are "dead" and everything else is all right, then the signal cable from the terminal "LSC" on the sectionalizing panel is open, or a cone is short-circuited. If a cone is short-circuited the trouble can be cleared by checking each group of loudspeakers as described under "Weekly Inspection and Check—Loudspeakers," page 185. The short occurs in the group of loudspeakers from which no sound can be obtained. When a short circuit occurs in a certain group this group should be left out until the trouble can be corrected by an R. C. A.-Photophone service representative.

Rattling noises of distortion of the sound may be caused by the fact that the loudspeaker cone is not

properly centred; by poor jack contacts in the amplifier; or by "pick-up" of interfering noises, such as radio signals or motor sounds.

3. Centring

Centring is accomplished by three linen strings spaced 120 degrees apart. These strings are so arranged in the cone collar that stress is not exerted upon it, but is taken up by the three strings which are tied together in the centre. Each suspension string is fastened to a small bracket, whose position may be changed by the rotation of a machine screw. A slight rotation of the screw will cause the cone to move perceptibly in the gap. Care should be taken to see that the tension on the strings is just sufficient to hold the coil centrally in the air gap.

4. Jack contacts

Keep all amplifier jack contacts clean.

5. Pick-up

Check all ground connections of the system.

K. Dial Settings for D. C. Motor Control

The R. C. A.-Photophone, Incorporated, furnishes a chart with projectors using the D. C. motor drive, giving the speed control and dial settings for different film speeds. The dial settings are subject to periodical changes in accordance with instructions given by the R. C. A.-Photophone Service representative.

L. Speed Control Switch Markings for D. C. Motor Drive

"Low" is for low speed picture operation: 75 to 90 feet per minute film speed. (Sound reproduction should not be attempted with the switch in this position.)

"Normal" is for sound reproduction: 90 feet per minute film speed. (Variable speed operation should not be attempted with the switch in this position.)

"High" is for high speed picture operation: 90 to 110 feet per minute film speed. (Sound reproduction should not be attempted with the switch in this position.)

It is very important that switches be thrown, as in-

dicated above, for the speed range desired before attempting to adjust the speed to an exact point by means of the control dial on the motor.

M. Connection Diagram

Connection diagram T-3870180 will be found in the envelope in the back cover of the book provided by the manufacturer.

N. R. C. A.-Photophone Service Representative

If further servicing is necessary, the R. C. A.-Photophone service representative should be consulted.

METER READING TABLE

JACK DESIGNATION	MEANING	SCALE READING	ACTUAL VALUE
ILB×1	Lamp current (amp.) on proj. B, multiplying factor 1	4.8 to 5.25	Amp. 4.8 to 5.25
ILA×1	Lamp current (amp.) on proj. A, multiplying factor 1	4.8 to 5.25	Amp. 4.8 to 5.25
IP1×1	Plate current (milliamp.) on tube 1, multiplying factor 1	3.3 to 4.5	Milliamp. 3.3 to 4.5
IP2×1	Plate current (milliamp.) on tube 2, multiplying factor 1	0.3 to 0.95	Milliamp. 0.3 to 0.95
IP3×5	Plate current (milliamp.) on tube 3, multiplying factor 5	2.5 to 5.	Milliamp. 12.5 to 25
EC12×1	Grid (bias) voltage on tubes 1 and 2, multiplying factor 1	9. to 9.5	Volts 9 to 9.5
EC3×5	Grid (bias) voltage on tube 3, multiplying factor 5	6 to 6.4	Volts 30 to 32

JACK DESIGNATION	MEANING	SCALE READING	ACTUAL VALUE
EB123 × 100	Plate voltage on tubes 1, 2, and 3, multiplying factor 100	5	Volts 500
EB4–13 × 100	Plate voltage on tubes 4–13, multiplying factor 100	10	Volts 1000
EC × 50	Grid (bias) voltage on power tubes (tubes 4–13), multiplying factor 50	5	Volts 250
EA × 2	Lamp and filament voltage, multiplying factor 2	6.6	Volts 13.2
IP Front Tubes	Plate current (amp.) on front power tubes	0.325	Amp. 0.325
IP Back Tubes	Plate current (amp.) on back power tubes	0.325	Amp. 0.325

NOTE: *Where reference is made in the Meter Reading Table to certain tube numbers, the following tubes and numbers correspond:*

TUBE NUMBER	RADIOTRON
1	UX–210
2	UX–841
3	UX–210
4–13	UX–845

The last number of each jack designation is a multiplying factor that must be applied to the scale reading to give the actual value in volts, amperes, or milliamperes, as the case may be. For instance: IP3X5—The reading on the meter is 5; the correct plate current is 5×5 or 25 milliamperes. EB4=13×100—The reading on the meter is 10; the correct plate voltage is 10×100 or 1000.

Part Three

THE STUDIO

CHAPTER VIII

THE STUDIO

I. Technique in Manufacture

It might have been more logical to begin this text from the point of view of production rather than operation. However, the advantages of procedure according to logic are dubious in an exposition of the kind that is attempted in this book. Frankly, my purpose in the preceding chapters has been to establish a grasp with the subject for the majority of my readers. In explaining the new phenomenon where most of us have met it, or can meet it most readily, I trust that I have gratified a curiosity as to the whys and hows of sound right where it is exhibited.

To stop here, however, would defeat many purposes. The inquiring spirit can scarcely be satisfied with an account of the mere externals of the matter. Even the layman must wish to comprehend what lies behind the immediate business of showing sound pictures in an auditorium. As for the manager, he must take the further step. It is not merely desirable for him to do so—it is imperative. He cannot yet leave the understanding of so new a phenomenon to paid technicians, for the simple reason that the connection between production and exhibition of sound pictures is much more intimate than in the case of silent ones. One of the themes I have to present is that producers now are obliged to anticipate theatre conditions more than ever. By the same token I hope to demonstrate that the operator, cut off from the knowledge of recent technique in manufac-

ture, would be a man lost, indeed. I refrain from stressing the fact here because it will become self-evident as we go along. I rest on the simple assertion that one who knows the subject solely from the theatre angle knows practically nothing about it. The basis, the true comprehension, lies in an acquaintance with the sources of the machinery of manufacture, its housing, and its manipulation.

With the coming of sound the motion picture industry has begun its second chapter of development. On May 14, 1928, American filmdom officially accepted the new form, when the Paramount Famous Lasky Corporation, the Metro-Goldwyn-Mayer Corporation, and the United Artists Corporation signed contracts with the Western Electric Company to install the Western Electric system of sound recording and synchronization in their studios. Fox Film Corporation and Warner Brothers, as well as First National Pictures, already had aligned themselves with the system. Soon afterward most of the important producers of motion pictures followed their lead.

About this time the Radio Corporation of America officially announced the perfection of its sound and synchronizing equipment, under the trade name of "R. C. A.-Photophone." The Pathé Exchange, R. K. O. (a subsidiary of the Radio-Keith-Orpheum Company), Educational Film Exchange, and certain others became its affiliated producers.

Huge amounts of money have been invested in soundproof studios, laboratories, and units auxiliary to existing studios. It is estimated that the investment in the construction and equipment of soundproof stages in California alone has reached a sum in excess of $20,000,000. This would indicate that California will be the centre of sound picture production, just as it has become the world's motion picture centre.

The Western Electric Company, through the Electrical

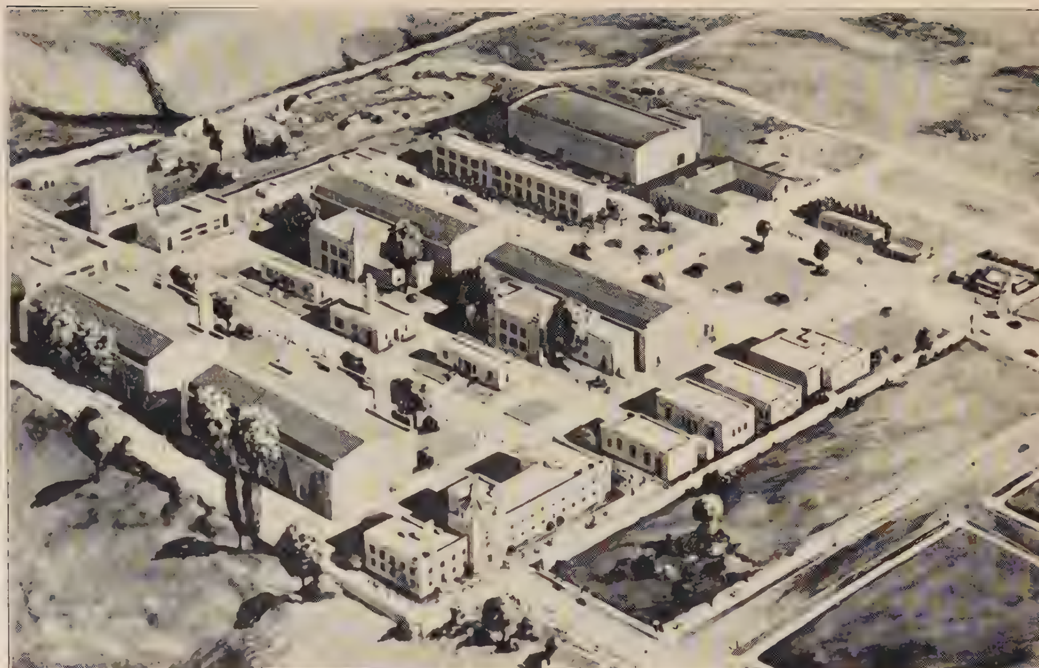

PLATE III. FOX FILM CORPORATION MOVIETONE STUDIO, LOS ANGELES, CALIFORNIA

Research Products, Incorporated, its subsidiary, has licensed its affiliated producers to use in their studios its apparatus for recording sound by both the disk method and the phonograph-on-film method, in which the sound is impressed on the edge of the film. These methods were developed in the Bell Telephone Laboratories and the Fox-Case Laboratories. The equipment for both is manufactured by the Western Electric Company. Among the Western Electric affiliated producers are:

Fox Film Corporation
Warner Brothers Pictures, Incorporated
Metro-Goldwyn-Mayer Corporation
Paramount Famous Lasky Corporation
United Artists Corporation
First National Pictures, Incorporated
Universal Pictures Corporation
Hal Roach Studios, Incorporated
Christie Film Company
Columbia Pictures, Incorporated

Approximately sixty production channels or units are, at this writing, in operation in the production of sound pictures.

In the early stages of the movement makeshift studio stages were used, but experience in connection with these primitive productions has established the need for a standardized equipment and studios that have been adapted generally by leading producers.

The Fox Film Corporation has just completed a studio at Fox Hills, near Hollywood, California, which is the largest structure erected for the specific purpose of producing sound motion pictures (Plate III.) Although the Fox Film Studio is by far the most elaborate, Warner Brothers have built several additional Vitaphone stages. The Metro-Goldwyn-Mayer Corporation has com-

pleted two stages with full auxiliaries and is planning additional stages as I write. The Paramount organization has completed four sound stages that are fully equipped, as well as two recording buildings. First National, United Artists, Universal Pictures Corporation, Christie Film Company, Hal Roach Studios, and others have extended their facilities along similar lines. Figure 4, page 201, shows the recording studio of the Christie Film Company and is a typical and simplified plan of the Western Electric System.

The Radio Corporation has equipped its own studios in New York, as well as the studios of its affiliated companies —R. K. O. Pictrues, Pathé Exchange, Mack Sennett Studios, Educational Film Exchange, World Wide Pictures —with its sound equipment.

So much for the national distribution of the device.

II. Systems and Equipment

The rest of this chapter will be devoted to description of the system in use in the studios of the companies mentioned above and will be concerned especially with the equipments known as the Western Electric System and the R. C. A. System of Recording.

All of the new studios are designed with the basic purpose of making them soundproof. They generally consist of reinforced concrete materials, although in some instances satisfactory results have been obtained by the use of other substances. In this way there have been obviated two of the most important dangers to studio recording: foreign noises and room echoes.

The soundproofing is accomplished either by using very thick masonry walls, or by building a double wall with air space and sound-absorbing materials within. In some instances the floors of the studios are covered with

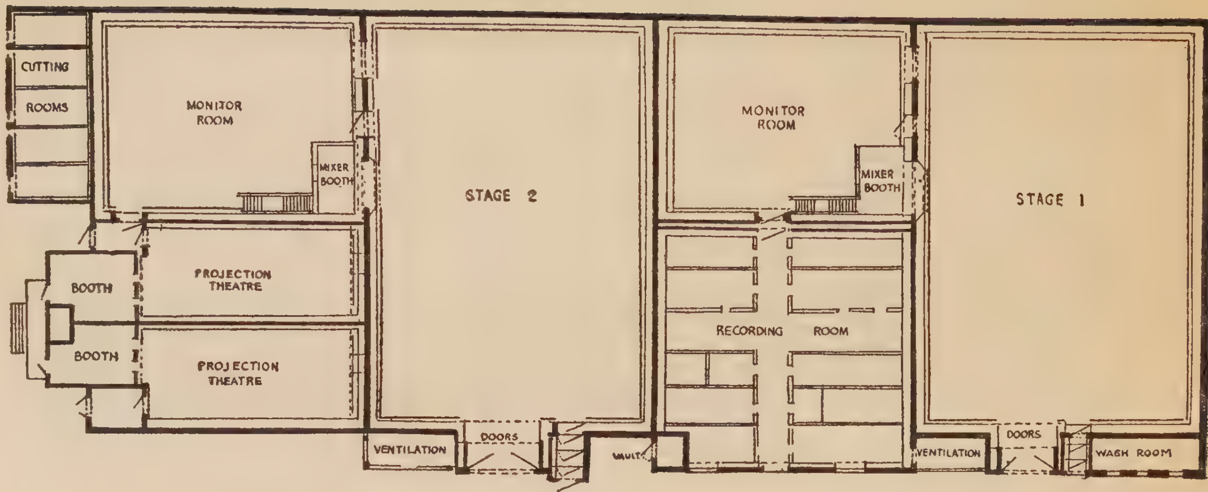

FIG 4. DIAGRAM SHOWING RECORDING STUDIO OF THE CHRISTIE FILM COMPANY

soft carpets. The inner walls and ceiling are likewise covered with sound-absorbing materials, from which heavy monk-cloth drapes are hung perpendicularly to the walls and ceiling. Such drapes as are hung are made movable and can be raised and lowered, so that the degree of resonance may be varied to meet the different conditions encountered during recording. The stages, furthermore, are made soundproof from street noises, from above, and from one another. In this way it is possible to have "sets" prepared on one stage while recordings are being made on a second.

It may readily be seen that considerable attention has to be given to the ventilation problem. Because of the importance of the elimination of machine noises, the installation of ventilation machinery requires special solicitude. Yet in the most modern studios the air is conditioned and completely changed every eight minutes; and the temperature and humidity in the rooms are controlled and held proper for maximum comfort. Such installation is indispensable if the highest efficiency is to be obtained for the artists and the working personnel.

III. The Western Electric System

The gross parts of the studio are quite interesting. We will concern ourselves first with the studio stage. The stages of more important studios were designed on the basis of actual experience with the studios of modern radio broadcasting rooms and from results of experiments with acoustical materials. The best way to get an idea of the operation of a sound studio is to watch a company filming a scene and to trace the sound recording right through.

One enters the stage through a soundproof sliding door. The latter is set in an insulated felt frame; once past the door the visitor finds himself in a large vestibule. The

door is then closed behind him. A second door now opens onto the soundproof stage where the company is in action. This door is also soundproof; furthermore, when it is locked it shuts out not only sound but also air. Suspended over the heads of the players, and just out of the range of the cameras, are placed the microphones that pick up the voices and carry them to the amplifying and recording apparatus. These instruments are very delicate and so sensitive to sound that the slightest whisper can be recorded. No one is allowed on the stage while the company is engaged at work; under no condition are people suffering with colds allowed to enter the stage while the scene is being "shot," for a solitary sneeze or a cough would ruin the scene. Those who are permitted upon the stage while scenes are being made sit on the side lines far away from any microphone; there they remain, perfectly silent, avoiding so much as an unnecessary movement, for it frequently happens that the rustling of clothes is picked up by the sensitive microphones.

The players have rehearsed their lines and are ready. The powerful electrical equipment is lighted. The cameras are either equipped with a soundproof housing, or are set up in soundproof booths about five feet square and seven feet high. These are known as "tanks." They are, in effect, movable small booths fronted with plate-glass windows in which are contained the cameras. These booths are likewise insulated with soundproof materials so that the clicking of the camera mechanism will not beat out into the microphones. The scenes are "shot" through the double glass window.

A series of microphones in convenient places, masked out of reach of the camera, catch the sound as it is spoken or sung. The proper placement and manipulation of the microphones is of great importance. The aim in every case is to set them wherever action is to occur and lines are t

be spoken or sung. With the aid of technicians and with due regard to the tonal quality desired the director supervises their placement.

Both cameras and recording apparatus, although separated by heavy soundproof walls, are in constant synchronization. For each frame of the film that passes before the aperture of the camera on the set one frame moves in front of the light cell in the recording room. If one machine were to move at a speed greater or lesser than the other the spoken words of the actor would be out of time with the action of the film. Perfect synchrony is therefore assured through automatic controls, first during the recording process, and later during projection.

It should be mentioned here that it is now standard practice for the sound to be recorded on the film $14\frac{1}{2}''$ ahead of the picture frame to which it relates. The reason for this is, that the recording and reproducing units first used with Movietone were situated below the camera and picture projection heads respectively, thereby placing the sound record ahead of the picture; and the length of film between the picture aperture and the sound aperture, through which the recording or reproducing light fell on the film, happened to work out at $14\frac{1}{2}''$. As this distance has been found convenient to work with in subsequent designs, it has become the accepted standard and is therefore followed by all makers of sound-on-film equipment.

The operators of the cameras, equipped with head phones, receive instructions while working their machines. Here standard camera equipment is used. In order to obtain uniform velocity of film in the booth without sacrificing quietness of operation, it has been necessary to install precision gears and to make all internal parts with the most exacting mechanical accuracy. A flywheel has accordingly been placed on the sprocket shaft and mechani-

cal filters have been incorporated to produce uniform motion of the sprockets. The cameras themselves are driven by synchronous motors.

On a glass enclosed balcony on the front part of the stage is the mixing chamber of the monitor room, where the sounds from the various microphones are properly mixed. This chamber is outside the stage, but through the double plate-glass windows it commands a complete view of all activities. The monitor room contains delicate sound-recording instruments. From an electric panel here all sound devices are controlled, and the output of the various microphones used on the sets are blended. This is done by delicate electrical measuring instruments that are manipulated by skilled operators.

It is here that the technician in charge controls the volume and modulation of the sounds and voices that are being recorded. A loudspeaker permits him to hear everything that is said on the stage, and without loss of volume. If a player's voice is too loud he reduces the amplification; and he reverses the process if the voice needs more volume. It may readily be noted that this man is the "heart" of the system. He exercises control through a monitor panel, which is a small table on which are mounted multicoloured lights, switches, and an intercommunicating phone. The operator is in earshot touch with every point of the elaborate system. While scenes are being photographed he transmits instructions noiselessly by flashing coloured lights.

An important link in the sound studio is the recording room, where the voice is impressed on disks, films, or both, as required. The recording room is located in the apparatus section of the sound studio approximately one hundred feet from the stage and separated from it by several thicknesses of soundproof walls. Here may be found the most delicate part of the system, for it is here

that the sensitive light valves change the faint fluctuations of electrical current set up in the microphones to tiny lines of varying intensities on the film. Later, when duplicates of this film pass through projectors in theatres, the tiny lines change light rays back into sound, which is then amplified through loudspeakers behind or around the screen.

Simultaneously with this light ray recording on the film, an impression is made on a wax disk similar to the usual phonograph records on apparatus in another recording room. This disk is known as the "play-back" record and is used as a check on the scene. Immediately after the taking of a scene the director may step into a room adjoining the stage and through loudspeakers hear what has just been recorded. In this way he may judge the quality of the scene and determine whether retakes are necessary. This room is a completely equipped sound projection chamber of adequate size and correct acoustical characteristics; and it is here that the film is judged for tone as well as for visual quality.

The amplifying room is virtually the only unit of the recording apparatus that operates automatically. It contains a multitude of vacuum tubes and electrical instruments that amplify the sound, as it is taken, to an intensity that permits recording in shadings of light and darkness on the film. When a scene is being recorded, this unit, having once been set by the engineer in charge, is henceforth automatic in its operation, although from time to time the operator at the "mixing" panel changes the degree of amplification to suit specific requirements.

The cutting rooms, where the sound film is edited, are adjacent to a screening room, because the cutters now edit their film by sound as well as sight. Scenes must be run through the projectors so that they may be timed properly.

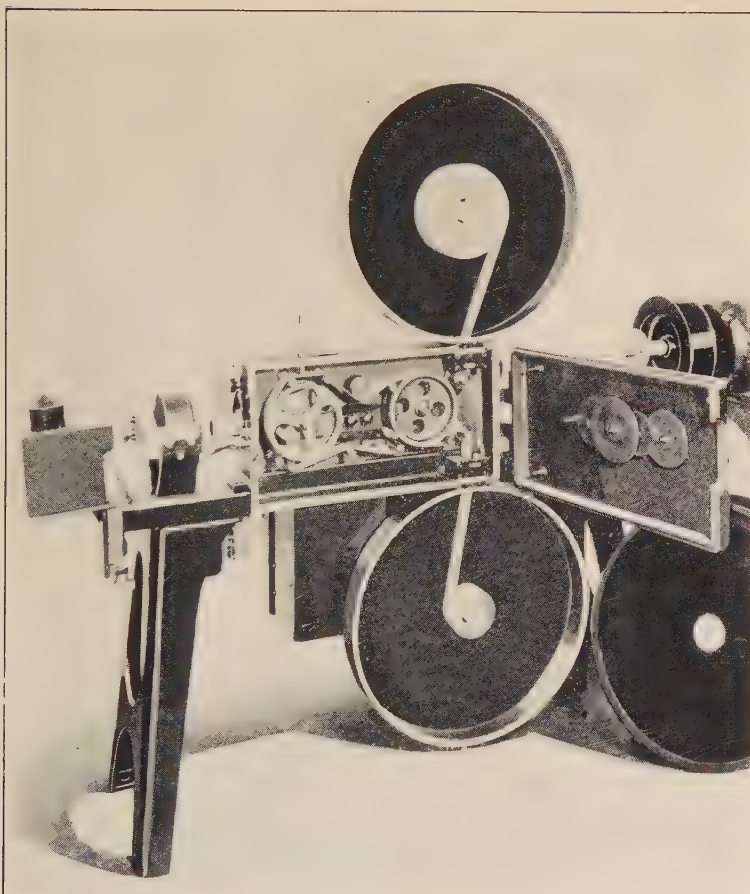

PLATE IV. WESTERN ELECTRIC RECORDING MACHINE WITH THE DOOR OF THE EXPOSURE CHAMBER OPEN

The screening room is fully equipped with a sound-reproducing device, and the pictures may be shown and heard just as they would be in a theatre. The apparatus section of a sound studio also contains stock rooms, test rooms, disk-shaving room and rest rooms, as well as offices for the technical staff.

Now that, in this section, I have presented the general features of the sound studio, we can proceed to consideration of individual types:

The following is a description of the Western Electric sound-recording apparatus and its operation:

Plate IV shows a studio recording machine with the door of the exposure chamber open. In this machine the film travels at the rate of ninety feet per minute. The sound track is made at the edge, away from the observer. Adding sound to the picture introduces no complications of technique other than the requiring of sufficient rehearsal to make sure of a satisfactory pick-up of the sound. One or more cameras and one or more sound-recording machines are driven by motors electrically synchronized, from a common distributor. Figure 5 is a diagram showing the studio equipment for sound recording. Provision is made for combining, if it be desired, the contributions of several microphones on the set. The combination is under the control of the mixer operator in the monitor room, who views the set through a double plate-glass window in the studio wall, as indicated in the early part of the chapter. The mixer controls the sound for the recording machines. The diagram shows relays which permit the mixer to connect the horn circuit either directly to the recording amplifier or to one or the other of the monitoring photo-electric cells in the film recorders. The electrical elements of this monitoring system are so designed that the sound quality heard in the mixer horns are the same as the quality to be expected in the reproduction in the theatre.

The programme is rehearsed until satisfactory arrangement of the microphones, and of all amplifier gain, is effected. In recording, it is of course necessary that the microphones be placed outside the camera field or that they be properly masked.

The intensity of sound varies inversely with the square of the distance. The problem of suitable position of the microphone is of utmost importance, especially during recording of soft sounds. When one is recording large orchestras and complex musical organizations, the sound must be properly balanced and carefully adjusted through the use of the monitor system. This monitor system is a replica of the standard reproducing system and this enables one to judge at all times how the reproduced record should affect the ear. In some recording work a number of pick-ups are used in order to combine and adjust various currents through the use of the mixing panel.

Acoustic treatment in the walls of the monitoring room secures the reverberating characteristics of the theatre, and the monitoring level is so adjusted that the mixer operator hears the same loudness that he would wish to hear from the theatre horns.

With no film in the machine a complete rehearsal is held. When results are satisfactory the film is loaded, the cameras and the sound recorders are interlocked, and starting marks are made on all film by punches or light flashes. A light signal from the recording room warns the studio stage, which, after lighting up, signals back its readiness to begin. The machine operator starts the cameras and sound recorders and signals the stage to commence. During the recording the mixer operator monitors the record through the light valves, thereby assuring himself that no record is lost.

In recording for disks the usual procedure is to use a disk from one inch to two inches thick and from thirteen

to seventeen inches in diameter, composed of metallic soap, with various additional agents to improve the texture. This is shaved to a highly polished surface on a lathe. The polished disk, or so-called "wax," is placed in a recording machine which is essentially a high-grade lathe arranged to rotate the "wax" in a horizontal plane at a

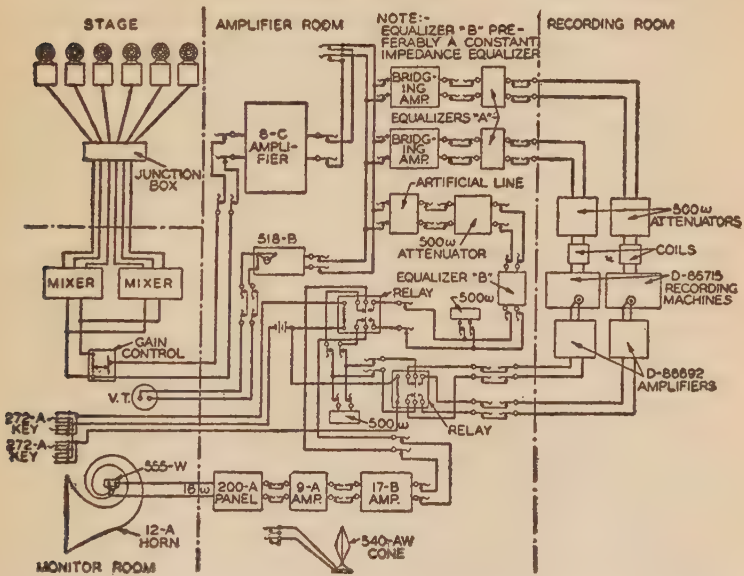

FIG. 5. DIAGRAM SHOWING STUDIO EQUIPMENT FOR SOUND RECORDING

uniform speed in a definite relation to the film, with which it is synchronized. After a record has been cut into a "wax," the latter may be handled and, with proper precautions, readily shipped from place to place. After a record has been cut the sound may be reproduced directly from the "wax" by use of a suitable pick-up or reproducer. The practical value in studio work in being able to let a

director or artist immediately hear and criticize the results of the effort can hardly be overestimated.

After a "wax" record is adjudged satisfactory, it is electroplated. This is called the "master." From it, usually, two test pressings are made. If these are satisfactory the master is in turn electroplated with a positive, being first treated so that the positive plate is easily removed. The latter is sometimes called an "original." From it, in turn, is plated a metal mould, or "stamper." From this duplicate originals may be plated; and from them duplicate moulds or "stampers." Because of the practice of making a number of duplicates it is possible to safeguard the "master" and insure against any accident that may destroy a valuable record. From a single "stamper" it is not unusual to make one thousand finished pressings.

Important advances have been made within the last few years in the design of electric reproducing structures. The bearing pressure at the needle point has been reduced, and proper mechanical loads have been provided so that the needle point will exactly follow undulations of the grooves without being set into continuous vibration. This results not only in a longer life for both needles and records, but (which is more important) in more faithful response to the higher pitched tones in the record. Incidentally, I may mention the fact that the developments of this type are due principally to the engineers of the Bell Telephone laboratories and it is now being used by the Victor Talking Machine Company in its apparatus.

Yet this process of sound recording on wax, synchronized to the film, has brought about a number of conditions not previously encountered in the phonograph field. The most important of these relate to the editing, cutting, and rearranging of a picture. Rearrangement of sound on records is entirely practical; portions may be deleted or portions may be added. Either the whole may be changed

or new sounds may be added to those already on a record. In fact, one may make any alterations of this sort which can be effected in the picture itself. The details involved in the operation offer no serious technical difficulties. The refinement of the disk and the extent of its future use is governed only by the demand in the synchronized motion picture itself.

IV. Outdoor Recording

A complete field or portable recording outfit consists essentially of microphones, a special amplifier containing a volume indicator, an A. E. O. light circuit, and a special sound camera. The last is operated by a 30-volt D. C. motor with rheostat control, drawing power from storage batteries or special spring motors, controlled by a governor similar to those of phonograph motors. The amplifier is operated by a 12-volt storage battery and a 400-volt dry cell B battery. The outfit is transported in a three-quarter-ton automobile truck and manned by a crew consisting of a camera man and a sound man. The apparatus has been simplified to such an extent that the recording work in most cases is being done by men having no special technical training. A number of such outfits are in operation at the present time, through the world, by divisions of the Fox-Case Corporation, in photographing Fox Movietone News, a talking weekly. Incidentally it may be noted here that the wide-open spaces have been found to give acoustically ideal recording conditions. Where a portable outfit is not available, experiments have indicated that it is possible to pick up voices on location and to transmit the sound by telephone to the recording room at the studio. This procedure requires careful timing and the most accurate integration between the technicians' work on the scene and that performed by the men in the recording room.

V. The R. C. A.-Photophone Recording Apparatus

The Photophone studio apparatus used in the recording process consists of camera, a sound recorder, an amplifier, a sound collector, and the necessary power supply devices. Standard cameras are used, except that the synchronous motor is substituted for the hand-crank or variable speed motor; and a device is added to mark on the film the starting and stopping points. The sound recorder is built to operate with little vibration and uniform speed and is also driven by a synchronous motor. The film is carried over a drum, with loops between the drum and sprockets. A small photometer is used to check the exposure. The optical system is somewhat similar to that used in the reproducing device; namely, a concentrated filament lamp and a system of lenses that produce an image of a slit on the film. The variation of exposed area on the film is obtained by means of an electro-magnetic galvanometer, similar to that used in oscillographs.

The moving system comprising a current-carrying strip and a small mirror is so designed that the response is practically uniform from zero to 6,000 cycles. This covers the practical range in speech and music. The sound collectors are of the type known as condenser microphones and may be used singly or in groups. Each microphone is connected to its own two-stage amplifier, and all are connected to a power amplifier adapted to control both the volume of each collector separately and also the volume after combining. The power amplifier may be located near the sound recorder and is equipped with a monitor loudspeaker. Power for the amplifier and the recorder is supplied by a storage battery and a small motor generator set. The recorder and the power amplifiers are preferably located in a separate room or, in outside work, on a truck.

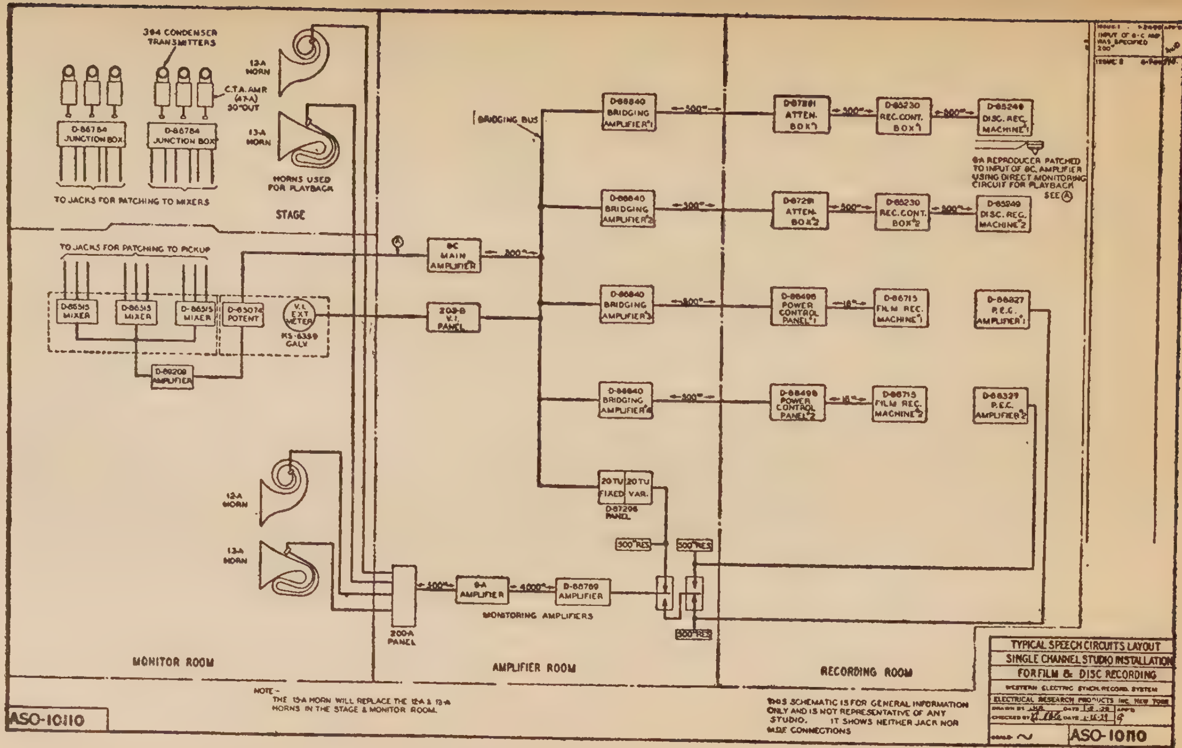

FIG. 6. SCHEMATIC ILLUSTRATION SHOWING LAYOUT OF COMPLETE RECORDING EQUIPMENT

Only the sound collectors and the cameras may be kept in the studio proper.

The method of recording employed by Photophone is different from that used by Movietone. In recording, the Photophone uses two films of different kinds in two different machines, one a standard motion picture camera similar to that used in photographing silent motion pictures, and the other a sound recorder. The camera uses the usual negative stock film, while a positive stock film is used in the sound recorder.

The motion picture is taken in the customary manner, except that the width of the camera aperture is .125 of an inch smaller than that of the usual silent picture camera. The film is developed and finished in the ordinary way, leaving, however, a blank space .125 of an inch wide between the picture itself and the sprocket holes on the side of the film. As the motion picture is made a "sound recorder" is in operation in precise synchronization with the camera and is recording sound on positive film of standard width. Both sound recorder and camera operate at the same speed of 90 feet per minute and are driven by synchronous motors.

On the studio stage, microphones are located at suitable points. The microphone is technically known as a "condenser" and each contains an exceedingly thin metal disk called the "diaphragm." These microphones are suspended from suitable frames by delicate springs so as to absorb vibration.

The sound recorder consists of two main parts, namely, an oscillating galvanometer, an optical system, as well as a motor-driven mechanism through which the film is moved continuously. The current emanating from the microphone, representing the sound waves in electrical form, is amplified through two stages and then carried forward to a main recorder amplifier. Located on this

amplifier is what is known as a "mixing panel" through which circuits from the microphones are combined. The current from the microphone first passes through the panel and directly to the main amplifier, where it receives four additional stages of amplification successively before being passed on to the loudspeakers. By this process the original current is amplified approximately one hundred million times. The current is now connected directly across the oscillograph galvanometer and recorder, which consists of a wire loop through which the amplified microphone current circulates. A small mirror is cemented to this loop. A small lamp supplies the illumination for making the photographic record on the film sound track. The light from this lamp passes through a small condensing lens and is focussed upon the galvanometer mirror. By means of the latter it is reflected through a second condensing lens and focussed upon a slit form through the microscopic adjustment of two sharp edges, so that an opening .002 inches high by .280 long is formed. On the opposite side of the opening there is a light beam of the same dimensions. This tiny beam is then passed through a small projection lens on the sound track of the film, and in the process is optically reduced in dimension until at the film it is only .0005 by .070 of an inch.

When the microphone is in action the galvanometer loop to which the mirror is cemented begins to vibrate, and those vibrations are in exact proportion to the electrical energy that is operative at or during any instant. This energy is itself governed by the vibrations of the microphone diaphragm, the loop and mirror vibrations being an exact duplication of the sound waves which create the current. The latter moves the light beam back and forth across the sound track of the film and in so doing traces on the film what really is a graph of the sound waves, the graph being the line of demarkation between the dark

and light portions of the sound track after it has been developed. When the sound film has been exposed it is developed until the record is opaque.

When both the picture itself and the sound track are finally completed both are placed in contact in the printer, together with regular stock positive film, and the positive print results. In this developing process each film has a starting mark by means of which the two are threaded in the printer in correct relation to each other, to insure synchronism.

VI. Lighting

The lighting used for the making of pictures at the sound studios is similar to that employed for regular motion picture work, and this is a good thing for the industry; for it is well known that picture making has to its credit the perfection of a splendid development in lighting. It would be unfortunate if the advantages gained through experience had to be discarded because of a novel venture. In instances it has been found necessary to quiet down the operating mechanisms and in some cases to change the reflectors in the Cooper-Hewitt lamps in order to prevent sound reflections. In some circumstances incandescents are being used. Since they are noiseless, these lamps are preferable to arc and mercury lights. There is very little doubt that with experience in this field of the work improved lighting equipment and panchromatic film will help solve some of the noise problems.

At the present time new Klieg lights have been developed that furnish brilliant and evenly diffused light, high in actinic quality. They permit photographing with clearness of detail and good colour value and yet are free from sound interference, besides being noiseless in their own operation. These include long-beam, high-intensity flood

lights of various types, as well as spotlights, which may be used for flood lighting, modelling, or sundry special effects.

VII. Other Changes in the Studio

The laboratory work in connection with sound pictures requires great skill in developing the film. When musical synchronization is used the film must be "duped" in order to superimpose the sound track for the sound picture. In printing the sound negative in combination with pictures for projection in theatres it is customary to print one negative, masking the space needed for the other, then run the positive again through the printer with the other negative but now masking the space already printed.

The laboratory work in connection with the development of sound motion pictures naturally brings several problems in a variety of connections.

It is expected that the results must conform to accepted standards that have been established for silent motion picture prints. There are technical problems connected with this subject that would be of interest only in the laboratory, since the problem is one of a highly technical nature. Although quite satisfactory sound prints have been produced it may be expected that the laboratory technique will improve with experience and study. With this will come betterment not only in methods but in process apparatus as well.

The disk system of sound synchronization makes fewer demands on laboratory technique than do the film systems. A machine, however, has already been developed to permit an entire reel to be processed as a unit. It has proved to be a great help in eliminating unnecessary noises.

Sound pictures have affected every department of picture production. Even camera men have undergone transformation. Whereas, in the past, a camera man could

operate at will on the stage itself, he is now confined in a soundproof booth, which brings to him many problems that he has not had to face before. In photographing ordinary scenes in silent pictures each shot is made separately. The camera is placed approximately twenty feet away from the player, and when close-ups are taken of the same action the camera is moved somewhat closer, and the lighting is changed accordingly. In the talking and dialogue pictures, both shots are made simultaneously, with the use of two cameras. One is focussed at twenty feet and the other at ten. The additional ten feet required for the close-up is accomplished through the employment of a telescopic lens. Thus is brought about a problem of lighting that must be considered, because of the limitations caused by the camera's being enclosed in the booth and the prohibition against "shooting" from many angles, as in the taking of silent pictures. Just now, however, much progress is being made in the removal of these limitations, and a large amount of freedom is being restored in the camera work, through more silent operation and the use of a soundproof hood over the camera, which accomplishes the same result for which a booth has hitherto been necessary.

Particular attention must be given to the costuming of the casts. The rustle of a skirt or of some metallic substance may be caught by the microphone. Again, new methods are being found every day in the building of scenery that help to give sound full resonance. The studio property department must furthermore face its own problem of delivering any kind of atmospheric sound that a director wants, with as little delay as possible. These sounds or noises cover a wide range: whistles of every possible description, woodland noises, wind machines, chimes, bells, automobile horns, are but few of the sounds that have become the "vocabulary" of the studio. Some of these

"sound props" may be phonograph records or sound film records. Others may be mechanical devices which produce a sound that registers better than the natural sound itself! A pistol shot, for example, sounds like something else on the screen. Therefore an electrical device has been created to produce a report that really sounds like a pistol shot when recorded on the screen!

VIII. Conclusion

Sound may be recorded at the time of the action. This sound may be special music, or effects intended to enhance the illusion of realism. A new technique is being developed in the expression of the new art, resulting from the combination of sound and pictures.

In the reproduction of musical accompaniment for a picture the sound recording may be done either at the time that scenes are being photographed or added later. Both methods are feasible, and each has its advantages. The method by which music is recorded after the picture has been completed seems to be preferable. The highest quality of reproduction is important, and it is frequently possible to provide a better type of music if the recording of musical accompaniment is done separately and apart from taking the actual scenes of a reel.

The fidelity of reproduction can now be said to have reached a fairly satisfactory stage. Speech has been recorded which is scarcely distinguishable from the original product of the voice, and this holds equally true for instrumental music. It has been found feasible also to transmit music and voice currents over large distances over telephone lines and to record these with satisfactory results.

The great added interest brought to the motion picture because of sound will encourage further inventive genius

in the studios. Sound and dialogue pictures have become a prominent and vital force within the industry. Now that the screen has found its voice a new art has been created. For many years news reels have brought distant lands and celebrities close to home audiences. The moving picture improved on the commercial photograph in that action supplemented features as a key to character. Now comes the talking reel, and we not merely see the King of Spain (to select one instance) but hear him speak. We hear him, and, what is more, he speaks to us directly, to the American people. The attractiveness of the man, the message he delivers, have untold possibilities for international accord. No less, they make actual, because of the medium of presentation, a fresh stimulus to interest in the theatre and in the industry. Another instance has even more remarkable elements: Bernard Shaw, with whose spirit we have been in touch through the printed page, but who will not cross the Atlantic, is nevertheless actually audible at last. Fortunate old man!—he has solved a dilemma by surviving it!

Yet when I speak of vistas of possibility, it is not merely of the reporter's function that I am thinking, or even of the bodily carrying over of drama from the traditional theatre to the mechanical. The fact that we can already transplant Fannie Brice from the *Follies* to the talking screen means only that the new equipment is ready to start where the stage leaves off. It has been all very well, for a transition and for the sake of distributing drama far and wide, to produce sound pictures that are simply faithful recordings of good plays. I am aware of the value and the permanence of this sort of duplication. I am aware likewise of the opportunity the cinema now has to make good an inherent deficiency in the production of great masters like Shakespeare, whose genius is deprived of much when there can be no appeal to the ear. Conscious as I am of all these ex-

cellent advantages, I am even more moved by another, a wider prospect.

The new power is more than a power. It is a challenge and an obligation. We shall not, I am sure, be content with what it pours into our waiting arms. We must rise to its potentialities, develop them to their utmost. Just as the moving picture offered a director the chance, in the fade-out and the close-up, to bring a character closer by revealing the inner thoughts and fancies, so sound offers him the gift of revealing thoughts. A play like *Strange Interlude*, for example, may prove more suited to mechanical than to personal methods of production. Art often acts the seer in this way—pointing the road that science is to create. So sound may redouble our resources not merely in the sort of response it arouses in audiences, but in the sort of matter it conveys to them. To create will therefore mean to discover and to invent a technique strictly arising from the nature of the process.

Here is the real business of production. I have every faith that we shall once again rise to the achievement.

CHAPTER IX

COMMENTS ON PRODUCTION

In the preceding chapter, on the Studio, I deliberately reduced comment to a minimum in the effort to present the technical features with rigid adherence to clarity. If I have succeeded in that attempt the reader possesses a definite and ordered conception of the structure and the machines of the creative workshop. For this very reason, however, the chapter gave none of those side lights of opinion and experience which might have amounted to digressions. In rendering the account of a new phenomenon one is often at a loss to decide what place to assign to the thing itself and what to the human reaction toward it.

At any rate, with the exposition proper behind me, I can safely turn to a miscellany of considerations relative to production which have an interest of their own. Some of these are in the nature of history, some are descriptive, some hortatory. All are observations, conclusions, confidences shared rather generally by active leaders of our craft. In a way, then, they constitute information; for they tend to indicate the human response of the industry toward the innovation, its difficulties, its gradual evolution. Certain of their interest in print, because they already have aroused interest in the trade, I gather these sundries of record, debate, and conclusion into the present chapter and offer them with the assurance that they will throw light from many angles on the complex institution we call production.

Although the production branches of the motion picture

industry quickly adapted themselves to the new conditions brought about in the introduction of sound in the making of motion pictures, the progress that has been made in that connection is nothing short of remarkable. What is more, great technical improvement will continue to be achieved. Virtually every important producing company has to its credit several talking or sound motion pictures that have registered marked advance over predecessors, considering the short time since sound was accepted by those within the industry. And it is well for the future of sound that the new art was accepted by men and women who recognized its possibilities and who handled it with sympathy and understanding. The resources of the largest producing organizations, together with their best equipment, were placed at the disposal of pathfinders, and the results have proved satisfying and promise much for the future. Almost every studio has organized a research department to familiarize the technician with the recording apparatus and to make a complete study of the changes that may be required in production methods.

In this connection, the Academy of Motion Picture Arts and Sciences, an organization consisting of the principal producing companies, and the Association of Motion Picture Producers lent early and valuable aid. Every phase of production, including acting, directing, writing, photography, and engineering, was made the subject of penetrative research. Rapid strides were taken in acquainting the personnel of the industry—the directors, the players, the writers, the technicians, the camera men—with the new form. Those in the production branch of the business realized that the future was in their hands, and that if there was to develop a lasting art the efforts made at the production centre would finally determine the destiny of sound in connection with the motion picture.

The introduction of sound, other than that by Warner

Brothers and the Fox Film Corporation, as recorded in the previous chapter, was effected at a series of meetings held under the auspices of the Academy of Motion Picture Arts and Sciences. Each division of the industry met in session and discussed projects and listened to lectures on the phase of the work in its own domain. Later, on May 2, 1928, the Academy held its first educational session on the subject, when the writers' guild of the Academy heard a description of the various systems of sound recording. The speaker of the meeting was Roy Pomeroy, a technician who had made a study of the subject of sound for the Paramount Famous Lasky Corporation. Here the technique of the talking script was discussed at great length. This convention was soon followed by an assembly of the technicians, at which the agenda pertained to the installation and operation of recording systems. Another meeting was held by the directors, who considered their own problems. In addition, there was a joint convocation of writers and directors, which included a pertinent demonstration by the Fox Film Corporation; and, finally, the actors' branch met to consider the contribution they were to make. Since then regular, periodical discussions have been held by these various branches of the industry, with the happy result of bringing home to the personnel the problems that had arisen and the expedients that had been adopted for solving them.

Meanwhile each great company erected soundproof stages and auxiliary rooms with the thoroughness characteristic of American industry, as I have reported in the previous chapter on the Studio, and as I write every major studio is equipped for the taking of motion pictures with sound. More than one hundred stages have already been equipped, and there are an equal number of portable equipments now in use.

In the beginning it was felt that the addition of sound to

motion pictures was but an embellishment—an effect comparable to that of a novel lighting or colouring system. However, it was soon found that a new art, revolutionary in the field of entertainment, had come into existence, one that would not only affect the making of motion pictures, but that might exert a material influence on the future of the theatre. At the outset, furthermore, most of the pictures were limited to the exploitation of accompaniments of sound effects and music, and in but few instances included dialogue. Practically all films, moreover, were made in duplicate as silent pictures for use in the many theaters that were not equipped for sound projection. As an indication of the progress that has been made, however, during the year 1929, let me say that more than three hundred and fifty major productions with musical accompaniment or dialogue, or both, have been scheduled by producers.

In order to keep those within the industry informed of the progress that was being made, and to familiarize them with the problems that still had to be met, a systematic control by questionnaire was inaugurated by the Academy of Motion Picture Arts and Sciences. At first the most difficult of such problems arose in connection with story construction direction and vocal rendition. Such problems, of course, were not to be solved as readily by research methods as by developments brought out through actual experience. In another direction research was already prepared to contribute. From the ranks of the large electrical organizations that had developed the various sound devices the technical forces of the studio were augmented, and the industry was schooled in the use of the apparatus involved. The cinematographers, beginning with the information thus made available to them, conducted further studies. In addition, many producers imported from the legitimate theatre dramatists and directors who brought

with them their experience in creating and directing dialogue. On their advice it was soon determined that whatever specific development there might be in talking pictures the general method of treatment would continue to follow the technique of the silent cinema.

Voice problems were given serious consideration, and after much experimentation and many tests by qualified university men it was found that the greatest success was attained by players who read their lines with perfect naturalness. It was also demonstrated that, though the legitimate drama had to take into consideration the fact that the voice must carry in a theatre, this issue was not of importance in the taking of motion pictures, since the microphone used in the recording of dialogue for the latter was able to pick up even the slightest whisper. If actors of the speaking stage are thus finding a new field for their talent, actors of the silent screen equally are showing amazing versatility. They are finding their voices, so to speak, and are discovering in talking pictures a new form of expression that lends greater scope and variety to their art. Directors are studying and mastering the new art and contributing to it the benefit of their experience and talent. Authors and scenario writers are busy studying and rewriting scenarios and plays in order to adapt them to the new medium. Naturally, some talking and sound motion pictures of indifferent production value have been and will continue to be made; for, after all, sound equipment is only an apparatus that is used as an expression of what happens to be in the minds of authors, directors, and players. Yet, although mistakes have been committed, they are more than natural to the development of any new art and are certainly no worse than those inflicted upon us when silent movies were first introduced. The thought to keep uppermost is that the introduction of sound with motion pictures, in changing the entertain-

ment standards of the entire industry, has sprinkled a few blunders among many excellent discoveries.

Every producer has accepted sound as essential in the making of pictures at the present time. The first chorus of adverse critics based their opinion of the future of sound on its current offerings. Since then a reassuring number of pictures have proved notably successful, not only at the box office, but as real contributions to the motion picture art. These productions are but an indication of the possibilities of the development that is still to come. We within the industry who possess imagination and vision see in sound the development of a new technique affording greater realism and entertainment for the screen. Surely it is to be expected that the introduction of sound will make more rapid strides in this modern day of achievement than the motion picture itself did when it first came on the screen and into an economic era now antiquated.

It is the belief of the present writer, for one, that sound will continue to play a very important part in the motion picture industry, and that eventually the use of sound will entirely change our present methods of picture making. Such changes as will occur will be gradual and will be assimilated in the same measure that progress assimilates the best in the old to the best in the new. There is enough ability in the laboratory and engineering divisions of the great electrical companies to eliminate any mechanical defect that now exists, in both the recording and the reproducing of sound. What remains to be accomplished beyond that is trivial. When recording and reproducing equipment are improved, just as radio equipment was improved, the real progress in sound pictures will come from the production brains of the industry.

In the early days of the motion picture itself there were those who felt that photoplays were a fad that had no future and that the business would revert to the primitive

procedure of showing short subjects only. Yet even though those who controlled the industry at that time virtually had a monopoly because of their patented holdings, this conservative pessimism did not stop the march of progress. When it was found that the motion picture was capable of greater expression the public demand and the vision of progressive forces commanded the development of the films, until they constituted the most popular diversion of the whole world. This evolution trained for the industry a talented group of directors, players, writers, and studio technicians. An amazing period of enterprise and achievement refined the possibilities of the photoplay to the point where it revolutionized all known standards of entertainment. Just as in those days, the industry is now going through an era of improving a new art, perfecting its apparatus, developing its technique, and nurturing a greater medium of expression. Silent motion pictures in themselves have limitations; pantomime at its best, for instance, has not been able to express itself adequately without the use of subtitles.

This brings up the question, Has the silent drama really been silent? From the time movies first flickered they have been accompanied by music—in some instances rather poor music. Now, for the first time, the producer is able to control the sound that accompanies the presentation and is free of the fear that his product may be exhibited to the weird "music" of some local performer.

How inadequate, above all, must be any attempt to interpret the true quality of the life about us without sound! Now that characters can sing or talk, it is surely insufficient that they continue to remain silent. Sound and voice have lifted the motion picture from pantomime to the heights of new power. In spite of the fact that the silent screen has registered tremendous progress, its ability to talk has brought to it greater opportunity for growth. As

might have been expected, there were many investors who resented the coming of this new thing that might affect their future. It is human to resent anything that is new, but sound challenges the best of the creative minds in the industry. Those that embrace it with intelligent application and sympathetic understanding recognize in it a higher type of dramatic expression and realize that in its development it is not necessary to sacrifice the fine traditions of film production.

Recent productions of stage plays demonstrate that these can be produced on the screen with much of the solidity and force of the original. The motion picture, however, is not a device solely for putting stage plays on the screen. Screen art, even with sound, must be considered in a light more of story-telling than of histrionic technique. Merely because the motion picture can talk it has not thereby changed its status. Rather, the motion picture with sound will continue, as in the past, to develop a method entirely of its own, with a much greater range than is possible on a limited stage. It is not by imitation that the talking screen will prosper, but by forging ahead in the same way that it did in its silent days. The sound motion picture will evolve its own actors, its own stories, and its own improved technique, and will bring to the screen a type of entertainment that has never in the past been possible. This contention has already been proved without question by the productions starring Al Jolson, by *In Old Arizona*, by *The Broadway Melody*, and by others of the same form. When sound is used properly, whether it be spoken, sung, or instrumental, it adds drama to the silent picture, gives it a new vitality, and makes it broader and more satisfying. Most prominent screen celebrities, too numerous to list, are successfully making sound pictures. Every branch of the production trunk of the industry is contributing to make a newer and greater

art out of the old. Sound is bringing to the screen a degree of sincerity, impressiveness, and entertainment never achieved before.

A different criticism declares that there may be situations in a type of motion picture that are not suited to dialogue. Very well. Such situations can perhaps be told more effectively with pantomime; and in such cases there is no reason why the sequence of scenes should not be handled in a most effective manner. The proof of the pudding, here, is that pantomime is resorted to on the spoken stage, where it has suited, not ruined, the action.

What of the writer? The development of the new screen art is likely to increase his importance, for the industry must exert its best efforts to encourage the creation of a new literature for the new medium. It is likely that the writer of to-morrow will prove of even greater significance than the writer of the past. He will be promoted to a plane of major importance; he is likely to occupy the same relative position to sound screen art that playwrights hold in the traditional theatre. Authors of imagination will write complete manuscripts in the manner of stage scripts. However, such writers will understand the fundamentals of screen technique. Their responsibility will not cease with the writing of a story, but in many instances will follow the story through its various phases of production until the final cutting. In this way they will understand requirements and become familiar with production problems. They will play a part in solving the latter.

A new type of story is already being devised—a technique that will bridge the gap between action and dialogue. The abrupt change of tempo when the dialogue stops and the action resumes will somehow be blended into a smooth-running continuity. If the problem is carefully studied there is no reason for sacrificing action or tempo in

talking scripts. Although certain modern stage plays will lend themselves for adaptation to the sound motion picture form it is likely that stories specially written for the medium will meet with greater success. It is even now doubtful that old stage plays, comic operas, and novels will best express the fast moving age in which we are living to-day. More than likely the plays and stories that thus lend themselves readily will prove to be the exception rather than the rule, although the script form in the writing of sound motion pictures will in some respects resemble the manuscript which is prepared for the stage.

Figure 7 shows a reproduction of script pages that show the difference between the directions for silent versions of motion pictures and for those containing dialogue. In this instance Paramount has produced two versions of the picture *Interference*. Though the players in both pictures are the same, the silent version was directed by Lothar Mendez, while the talking version was made by Roy Pomeroy. In following the specimen script of the latter it will be noted what great latitude is given the director for dramatic direction. Though the silent form goes into detail as to the facial expression or "business" that may be required of the player, the dialogue version touches lightly on this, leaving practically all of it to the judgment of the director. Moreover, though there is a similarity of title and action, the real difference is in the photography. The dialogue treatment subdues all the pantomime, leaving most expressions to be registered vocally—for example, in revealing that Voaze is drunk. The proportion of "business" required in the silent version as against the talking one may similarly be indicated by the fact that the synchronized *Interference* runs three hundred feet less than the silent. In other words, talking pictures are different enough to require less footage.

In the production of sound pictures the director with ex-

perience in motion picture technique has proved more than equal to the task. Practically every successful venture has been directed by old hands at the game. They have made themselves familiar with the possibilities of the new art, have entered upon their tasks with enthusiasm, and have evinced great talent in making the sound motion picture a finer entertainment. It is but a step, for example, from the photographic fade-out to the sound fade-out, or dissolve. It is but a question of experiment to determine the proper "timing" for the photographing of dialogue. Although the director has had to put aside his megaphone, by careful planning and rehearsing he has been able to control his cast as heretofore. Moreover, he realizes that dialogue should be used only when it is relevant to the story, that there are situations not at all suitable for dialogue. In such instances, he has proved pantomime to be effective to the accompaniment of music or sound effects or both. Finally, he has learned that proper casting for sound motion pictures requires selection of voices of decided contrast, as an advantage in making the characters stand out distinctly because of individual vocal traits.

The routine in the making of sound pictures is similar to that of the filming of silent motion pictures. The director generally rehearses the cast until it is perfect in lines, gestures, cues, and timing. Sometimes the first record made is a trial, known as a "play-back." This is a device which was originally developed by the Victor Talking Machine Company in testing artist recordings. It is nothing more or less than a phonograph record, which the director and players may hear repeated to them through loudspeakers located in the monitor room, or on the stage. In this manner they can give ear to the reproduction just as it would sound in a theatre of moderate size. This expedient not only offers a check on the scene, but reveals to the technician in charge of the mixing panel in the monitor room the re-

"Interference"

Silent Version

D-39

Interior Deborah's Living Room—Medium Shot: Deborah is pacing nervously when she hears the bell. Feeling that it must be either the reporter or Marlay, she smiles triumphantly, crosses to the door quickly and opens it—revealing Philip, who stands swaying in the doorway.

D-49

Close Shot: Of Deborah and Philip as they face each other through the doorway. Deborah can hardly believe her eyes as she sees him. She looks at him — unbelieving — stands dazed—unable to say anything for a moment. Philip makes a little gesture with his hand, saying, "Well, here I am!" Deborah gazes at him wide-eyed—speaks his name in a sort of hush: "Philip!" Philip, quite satisfied with the impression his entrance has made on her, smiles, and with a little bow of his head, indicates, "May I come in?" Deborah moves closer to him as she draws him into the room. She is eager now, joyous. Philip's steps are a bit unsteady.

D-41

Medium Shot: Deborah brings Philip down near her desk, talking happily—now almost beside herself with joy at seeing him again—crooning over him like a mother over her child. She takes his hat, starts to help him out of his coat—and, as she is pulling the coat off, Philips says with a little smile, still a bit out of breath:

Title 17: "Celebrating an early funeral! Going to snuff out, Marlay said!"

Deborah looks at him quickly as she hears this, drops his coat on a chair near the desk, then comes to him and says eagerly:

Title 18: "Then you did see him?"

All Talking Version

Sequence "D": Dialogue—Ernest Pascal:

(Hangs up receiver. Remains at phone.)

(A shadow appears at door, and a knock is heard. Deborah rises—goes to door—opens it.)

Voaze:

Enters. (Very drunk and rocking on his heels.)

Deborah:

"Philip!"

Voaze:

"Who says I can't climb a flight of stairs, eh?" (Paroxysm of coughing racks him.)

Deborah:

Philip! (Closes door).

Voaze:

(Throws down hat and stick. Takes off coat.) "Surprised—see me—sweetheart—eh?"

Deborah:

"Philip!"

Voaze:

(Throws coat over chair.) "You look fine—a splendid woman, Deborah, in this light—ha ha! Well come—nothing to say?"

Deborah:

"Philip! You're drunk!"

Voaze:

"Celebrating an early funeral. You're going to die, says he—snuff out—"

Deborah:

"Who said that?"

Voaze:

"Marlay! Sir John Marlay."

Deborah:

"Then you did see him!"

FIG 7. SPECIMEN SCRIPT PAGES OF PARAMOUNT'S "INTERFERENCE"

cording quality of the sound. As the player strays from one hidden microphone to another he cuts one in and the other out. If the best results are to be obtained he must learn to do this in a careful and painstaking manner.

Screen players who have gone right to the top, to stardom, without ever having to speak a line, now find a new condition facing them. A personality in itself means little if the voice destroys the illusion. Therefore such players must be more than clever pantomimists. For those who have feeble or rasping voices there remains only the doubtful possibility of a "voice double," an invisible speaker who keeps time to the lip motion of the performer. There have been instances when this feat has been accomplished with a degree of success. Too, technicians have held that it is possible to devise a filter, either in connection with the microphone or in the amplifying device, which may tend to make a voice attractive by eliminating the high frequencies or increasing the low frequencies. A very large number of the contemporary personalities in motion pictures, however, have been able to adapt themselves to the new conditions without artificial aids. Many of these have the necessary youth, the screen experience, and the confidence. Such a production authority as Jesse L. Lasky has stated that in his opinion the great majority of those who are now making motion pictures will appear successfully in connection with sound pictures. In fact, Mr. Lasky places his estimate as high as 95 per cent.

The sound pictures that have been produced with success so far have indicated that players who are trained in the technique of screen acting and who have pleasing voices have fulfilled all requirements. What the public will expect most in dialogue pictures is a clear, understandable voice rather than one that is specially trained for that purpose. The natural voice will go farthest, for the first and most important requisite of a player is to be understood.

The players in the pioneer talking subjects, in their anxiety to reach the microphone, lost sight of the fact that their utterances must be accompanied by natural facial expression and gestures.

There are those who are close to production, moreover, who maintain that the importance of voice is greatly exaggerated; that there is no place on the motion picture screen for stage acting; that players will be expected to "feel" their scenes; and that if they do this, all that is necessary is the natural tone. It is important, however, for players to speak distinctly and to pay particular heed to the lower register of the voice. The question of volume, as I have explained, is not of great moment. As in the case of the radio, the so-called "whispering" voice is no handicap. It can be amplified at will at the control board. Thus, since players for screen talking pictures need not worry greatly about developing volume, they should devote themselves rather to the development of correct diction. Nor is it imperative for performers to have stage training, since it is a recognized fact that screen acting is very different from that of the stage. As a matter of fact, many players of the silent drama will probably have a longer usefulness if they enter sound than if they continue with silent pictures alone.

On the other hand, talent from the legitimate stage is being given every opportunity to appear in sound motion pictures. Many of these performers who are already popular have added success and prestige to their work. It is a well-known fact, however, that many charming personalities do not photograph as such on the screen. With these and other facts to guide, players are being developed who will make out of screen acting a real art. Some screen personalities will enhance their value; others will step aside to make room for those who are more adaptable to the new standards. Vast fields are opening opportunities

to-day to actors, writers, and directors who have the foresight and vision to recognize their opportunities, for the coming of sound means progress, not merely to the film, but to those who will contribute to it and grow with it.

To what extent the foreign motion picture star will be affected by the addition of dialogue to motion pictures, time alone can say. It is doubtful, however, whether European accents can be adjusted to fit the requirements of the American market except in parts that call for such accent. Foreign artists who have experience in American-made motion pictures should be of considerable value to motion pictures produced in their own countries.

Thus far in our inquiry we have been either emphasizing sound as apart from sight, or even dealing with it exclusively. That is right and necessary, for it is the newer element that provides our text. However, if we stop for a moment to think of the *whole* reality, we see at once that the industry is concerned not with the novel facility alone but with a double appeal, a combination of appeals, to the ear and the eye *together*. Such an attitude, in its comprehensiveness, might lead one to jump at the conclusion that we are in the midst of a movement to substitute machines for men, i. e., talking moving pictures for stage dramas or other stage entertainments. The conclusion, furthermore, would seem to be supported by evidence, for *Interference*, among other productions, appears to be a "canned" version of a "real" play, just as a Martinelli record is a "canning" of the maestro's art.

Granting the instance—it can be refuted!—for the nonce let me ask how far it carries us. In what sense is *The Broadway Melody* the mere "canning" of a stage play? Is there no sign, for example, of the influence, the dominance, of the technique of the silent cinema? Consider the number and variety of scenes, for one thing. But beyond and above that there is the simple fact that a sound picture *is* ma-

chine made—and, by that very token, different! Some of the differences, I admit, are at present deficiencies. Yet at least one is a triumph: we have now a closer approximation to a full, rich, rounded representation of life than has ever been offered by stage or screen alone. All the tricks and merits that either of these possesses are possibly to be combined by the machine into a complete consummation of illusion. The discovery of the maximum of that illusion is the first task of production. I have every faith that we shall achieve that knowledge yet—yes, and in the very act of manufacturing a product ever developing, ever evolving to meet the ideal!

CHAPTER X

THE FUNDAMENTALS OF SPEECH, MUSIC, AND HEARING

THE chapter on acoustics, in the part of this volume devoted to the theatre, was not, as the reader knows, a mere gesture of respect to theory. On the contrary, it revealed the forces and limitations of nature that not merely respond to the machine but make its function possible. Reverberation and absorption were seen to be physical realities which at times threatened and at times aided exhibition, but which in either case must be controlled in order to guarantee definite effects. The discussion revealed management in the act of "managing the theatre" with a vengeance!

If the study of "inanimate" nature be important, what can we say of the study of that animate mystery, man, without whose voice and ear the whole combination of machine and auditorium would be impossible! If we use the term "mechanism" in place of machine, we find ourselves considering two of the oldest machines on earth—the organs in the body that produce speech and song, and the organs in the body that receive speech and song back into the body! And although, as I have said, the whole business is a mystery and a miracle, nevertheless, the observable apparatus has so long been part of knowledge and so often explained and understood that, by comparison with the novel, complex machine that is the handiwork of men, the older creation of God is at least on the surface quite easy to comprehend.

The physical phenomenon of sound, instrumental or vocal, is of great importance to those interested in the new phase of our industry. The director's sense of hearing must be such that any difficulty in that respect should not result in either diminished or exaggreated volume of tone. The ear is one of the most sensitive organs in the human body, and sense of hearing is frequently affected by the physical condition of a person. People with colds do not hear as clearly and distinctly as when they are normal. Players must be in good physical condition to record properly. I therefore feel that a good understanding of the subject, providing the fundamentals of speech and hearing, may be of value to those whose work brings them in close contact with the various apparatus of recording and reproduction; and it will be my purpose, in this chapter, to point out some of the elements of the science of sound, as they affect the development of the picture.

As to the origin of human sound, there is a difference of opinion. The great Frenchman, Diderot, at the end of the Eighteenth Century, and Herbert Spencer many years afterward, expressed themselves as of the opinion that singing came after speaking. They suggested that at some time in the dim past human beings, in order to make their speech more effective and moving, sang the words instead of speaking them. In contradistinction, the theory of Darwin is based on a supposition that from the beginning the songs of animals were given them to call and to please one another. According to this theory, then, song came first with the animals, and speech afterward with men. The contentions of Diderot and Spencer, that speech came first and song afterward, is difficult of belief, because, in observing the growth of a small child, we can observe that speech and singing begin and develop simultaneously.

The synchronization of sound with motion pictures unites two different elements; one, the recording and re-

producing of vibrations affecting the sense of hearing; the other, photography and its reproduction. The success that has been attained in the development of both is due to researches carried into the study of the fundamentals of each. Scientific theory is herein concerned with five elements: one pertaining to hearing, one to speech, one to music, one to sound instruments, and the other to the voice. It stands to reason that in the transmission of dialogue, music or sound, the entertainment requirements make it important that the naturalness of the speech, music, or sound be preserved.

Let us first consider the mechanism of speaking. The organs involved are the lungs (which by their bellows-like action furnish the streams of air which pass in and out through the vocal passages), the vocal cords, the tongue, the lips, and the cavities of the nose and throat. These last impress on the air streams certain variations which are heard as speech sounds. In Figure 8 is shown a cross section of a human head, giving the relative positions of the organs I have named. The vocal cords are a pair of muscular ledges on both sides of the larynx, forming a straight slit through which the breath passes. The vibration of the vocal cords starts a train of sound waves which are conducted through the vocal passages. These in turn contribute certain resonant, characteristic vibrations that finally emerge from the mouth as speech sounds.

The human voice may be likened to a wind instrument, composed of two reeds. The so-called vocal cords are held at their ends on one edge, the other edge of each cord vibrating in the column of the air which terminates in the nose and mouth. The cords always act together, for it is impossible to produce voice with but one of them. They are fixed to the largest cartilage of the larynx, by means of a tiny little knob of cartilage delicately jointed to the part that it rests on. Consequently it may be tilted in several

directions. When one sings these little knobs are tilted backward so that the cords are made tighter when the voice ascends in pitch, and are tilted forward so that the cords are made slacker when the voice falls in pitch.

All speech sounds are produced in this manner, except

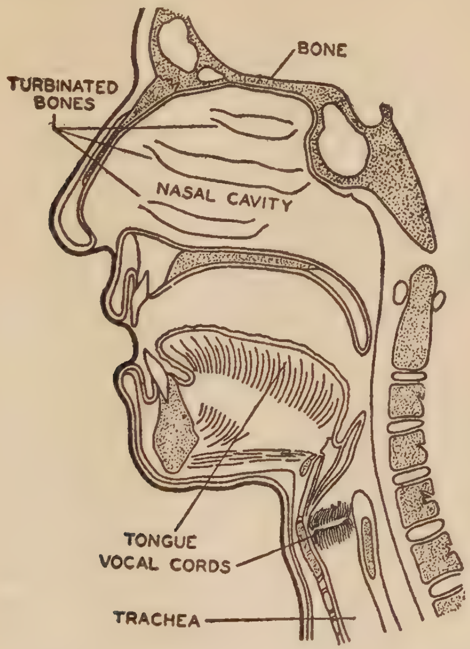

FIG. 8. CROSS-SECTION OF HUMAN HEAD

those usually symbolized by the letters *h*, *p*, *k*, *t*, *f*, *s* (as in the word *set*), *ch* (as in the word *church*), *sh* (as in the word *show*), *th* (as in the word *tooth*). These are called unvoiced sounds because the vocal cords play no part in their production. They are produced by frictional vibrations set up in the mouth itself. Again, both voiced and unvoiced sounds may be classified differently; those produced by a

continuous flow of air, called the continuants, and those produced by a sudden stoppage of air, called the stops. In the former class are such sounds as *a*, *v*, and *f*, and in the latter class such sounds as *p*, *g*, *d*, and *t*.

Although the vocal cords lend quality to the voice, they do not give, in any degree, distinguishing characteristics to the speech sounds. These are produced principally by the mouth and nose cavities, as is evidenced by the fact that we can readily understand whispered speech, in which the vocal cords play no part. The cavities are therefore similar to an organ pipe which augments the sound of the vocal cords. Since, however, they are movable, they make different tones just as an organ pipe might, were it flexible and could it be formed in different shapes. The limitations of the movements of the mouth and nasal chambers are such that they extend only to certain ranges, so that each voice has peculiarities of its own. A small amount of energy is given off by the voice in sound waves, although a great deal is used in arranging and rearranging the movements of the tongue and lips. These form the proper cavities for the generation of words and other sounds, and it is such variations that cause speech.

Experiments have shown that counterparts of the lungs and vocal cords may be located outside the body and still produce speech. Once one has a clear picture of the mechanism of speaking it is simple to see how an electrical apparatus can be made which will produce sound. This feat has actually been accomplished by the artificial larynx, an apparatus developed by the Bell Telephone Laboratories, for the benefit of a person who has had his natural larynx removed. Although the quality is, of course, different from that of the human voice, the speech produced is decidedly understandable.

Now, to consider the ear. The real use of this organ is to catch the waves of sound. From the outer ear there leads

inward a little channel called the "canal," along which the sound waves pass. At its inner end the canal is closed entirely by a piece of thin, delicate membrane which is exactly like a drumhead. It is appropriately called the drum of the ear, or tympanum. If we could see beyond the eardrum, we should find that it made one of the walls of a little space, or chamber, hollowed out inside one of the bones of the head. This second space is known as the middle ear. The bone in which it, and also the inner ear, lie, is called the petrous bone, and is the hardest in the whole body. This is especially interesting because a hard bone must undoubtedly conduct waves of sound very much better than a soft one, and the petrous thus illustrates a fundamental in acoustics. The middle ear is filled with air, which is fed from the throat. For the purpose there runs from the back of the throat, on each side, a little tube which goes to the middle ear and conveys air to it. In the middle ear is a minute chain of three small bones, much the smallest in the body, which are known as the hammer, the anvil, and the stirrup. The handle of the hammer lies against the drum of the ear. The hammer is jointed to the anvil and the anvil to the stirrup, and the foot of the stirrup lies against another sort of drum which leads to the inner ear. Needless to say the bones take their names from objects they resemble.

This chain of bones carries the sound waves across the middle ear. Every time a sound wave causes the drum of the ear to vibrate it sets in motion the hammer bone, which is fastened to it, and so the vibration goes on. Lastly, there are two very tiny muscles which pass into the middle ear. These have opposite uses and are called to action when we want to hear a sound more acutely or less acutely. One is so arranged that when it pulls it tightens the drum of the ear. That makes the drum vibrate more energetically, with the result of better hearing. The

other muscle has just the opposite effect; it is attached to the stirrup bone in such a way that when it pulls the bone cannot vibrate and thus interferes with the conduction of sound to the inner ear. For example, when a noise is unpleasantly loud we throw this muscle into action. The whole purpose of the chain in the middle ear is to carry the sound waves from the drum on its outer wall to a similar sort of membrane on its inner wall.

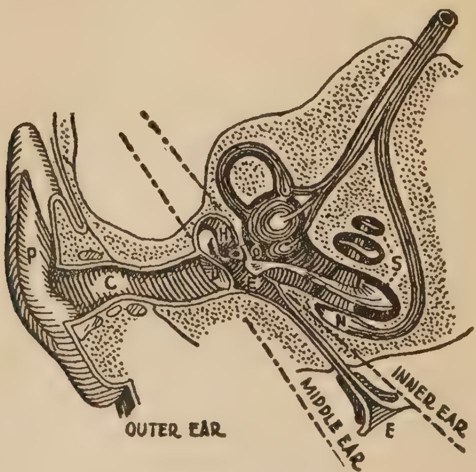

FIG. 9. CROSS-SECTION OF HUMAN EAR

On the inside of this is the third compartment, the inner ear. It is filled with fluid, and every sound that we hear reaches the nerve of hearing by conduction through this fluid. The main part of the inner ear is a tiny and very delicate bony structure, spiral in shape. Figure 9 is an illustration showing the arrangement. Along the whole length of the canal, stretched across it from side to side, there is a sort of platform made of delicate fibres. Their number runs into many tens of thousands. Just as the canal becomes narrower as it reaches the top of the spiral,

so do these fibres grow shorter. Upon the whole length of this series of fibres there are perched a number of small cells, each of which has what might be likened to short hairs sticking out from it, and these little hairs line the fluid of the spiral canal. The sound which reaches the hair cells of the inner ear sets up in them a nerve current which runs to the brain. It is that current, exciting the hearing cells in the brain, that enables us to hear. One has some notion of the number and delicacy and variety of the currents that pass along these nerves of hearing by simply considering that when he hears a big orchestra each instrument is recognized separately. It may thus be seen that what sound does after entering our ears is to startle certain nerve currents in the terminus of the nerve of hearing.

Human ears differ in their capacity both to hear sound and to recognize pitch. The limits of audibility at the lower end of the scale are given as from 12 to 33 vibrations per second, and at the upper end as between 20,000 and 40,000. The range of musical tones, however, lies between about 30 and about 4,000—some seven octaves. About 4,000 vibrations per second, sounds are heard as squeals and squeaks and are practically indistinguishable in pitch. The normal range of the human voice is from approximately 60 per second for low bass to 1,300 for high soprano—more than four octaves.

Figure 10 shows the range of pressure and frequencies that the ear can register. Frequencies above about 20,000 cycles or below about 20 do not register as sound. Any frequency is recognized as sound if its pressure is above the lower boundary curve marked "Threshold of Audibility." The upper boundary, marked "Threshold of Feeling," indicates the degree of pressure at which feeling begins. Above this line sounds are felt to the degree that they actually cause pain through excessive pressure.

Studies on the wave forms of speech sounds have shown that the pitch of a man's voice is of an order of 128 cycles per second, that of woman's voice that of an order of 256 cycles. In each overtones of the fundamental cord tone occur. Such studies have indicated that frequencies of as high as 8,000 or 9,000 cycles exist in different speech sounds. In general, woman's speech is more difficult to

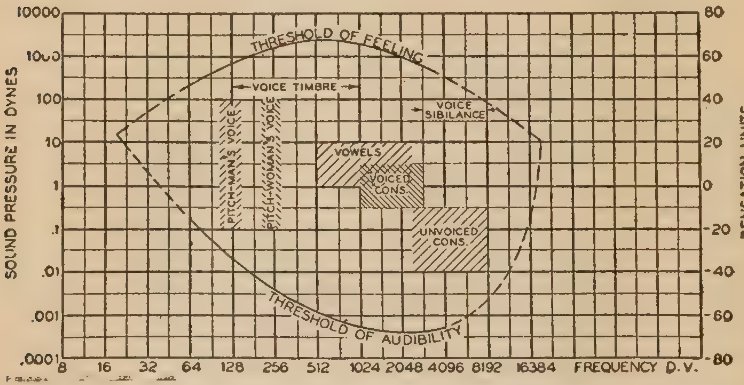

FIG. 10. CHART OF PRESSURE AND FREQUENCIES REGISTERED BY EAR

interpret than man's and has only one half as many tones as man's. The greatest differences occur in the case of the more difficult consonant sounds, which in woman's speech are not only fainter but require a higher frequency range for interpretation. The range from 3,000 to 6,000 cycles of a man's voice corresponds approximately to the range from 5,000 to 8,000 cycles for woman's voice. Since the ear is less sensitive at higher frequencies and the sounds are fainter, their difficulty of interpretation is proportionately greater. It can readily be understood that this difficulty of interpretation requires special attention on the part of the director and his technical staff.

Let us now consider for a few moments the physical nature of musical sounds. They are characterized by being sustained at definite pitches for a comparatively long time and by having the changes in pitch take place in definite steps called the musical interval—thirds, fifths, octaves, etc. There are two outstanding physical mechanisms besides the voice for producing musical tones; namely, vibrating strings and vibrating air columns. The piano and the violin are examples of the first; and the pipe organ, the flute, and horns are examples of the second.

A single note sounded by one of these musical instruments contains more than one frequency. The lowest frequency, called the fundamental, usually determines the pitch; but there is, in addition, a large number of component frequencies called harmonics, each being a simple multiple of the fundamental frequency. It is this abundance of harmonics that produces the richness of musical tones. The component having the lowest frequency *usually* but *not always* determines the pitch. It is very easy to produce, in the laboratory, musical tones having a definite pitch corresponding to 100 cycles without using any frequencies below 500 cycles. If pure frequencies of 500, 600, 700, and 800 cycles are sent into a receiver a musical tone of low pitch corresponding to 100 cycles is produced. The intensity of the sound during the rendition of an orchestral selection varies over very wide ranges, sometimes as much as 100,000 to 1. Naturally, this fact makes it difficult to handle the proper transmission of such music.

Musical instruments, to repeat, are divided into two classes—string instruments and wind instruments. Tones of string instruments, produced by plucking, striking, or bowing, usually are reinforced by resonating air cavities or sounding boards. Wind instrument tones are produced by the aid of reeds, as with the clarinet or flute, or by the

lips of players acting as reeds, as with the horns. Each class may be further subdivided into melody and harmony instruments. In the former one note is usually produced at a time; in the latter several notes may be produced simultaneously. In general, harmony instruments are capable of producing notes of a much wider frequency range than melody instruments. Therefore a given type of instrument of the latter class may include several in-

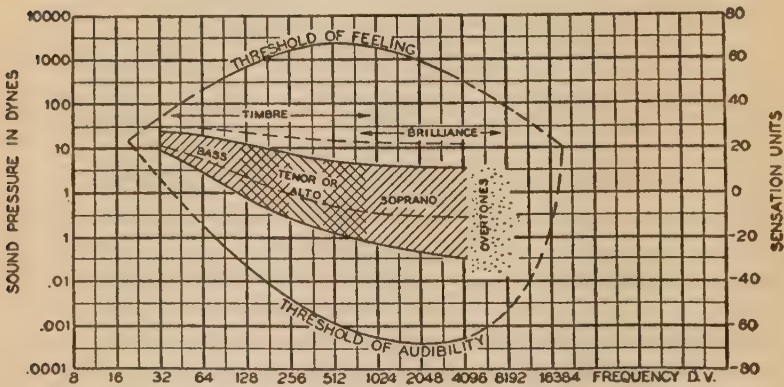

FIG. 11. CHART OF FREQUENCY RANGE

struments, each covering different frequency ranges, such as the bass, tenor, and alto trombone.

Experiments have indicated that notes of different frequency or pitch as produced by a musical instrument appear about equally loud to the ear. This similarity might be expected, since the ear has played an important part in their design. In Figure 11 contour lines of equal loudness are shown for the frequency range of from 32 to 4,000 cycles, which has been divided into three parts, the bass, the tenor or alto, and the soprano registers, corresponding to the notes produced by various instruments. The contour lines indicate that the notes of the lower registers have

greater sound pressures than those of the higher. The range of pressures for various instruments, however, is smaller for low notes, as has been determined by direct measurements of the pressures produced when the instruments are played by musicians. Contour lines for loud tones show a smaller change in pressure in going from low to high notes than do the contour lines for faint tones; so it would seem that music played faintly would cover a greater pressure range than loud music.

Percussion instruments, such as drums and the various accessory traps, produce the greatest pressures that are used in music. Although the fundamental frequency of the notes which they emit is fairly low, the complete notes are particularly rich in tones of higher frequency, extending as high as 10,000 cycles. Although these loftier tones die out rather rapidly, they are essential to good definition, or clearness. The organ, the piano, and the harp have the greatest span, covering a frequency range from about 16 to 4,000 cycles. All three of these instruments are characterized by a rather prominent first overtone, so that their effective range extends as high as 8,000 cycles.

Melody instruments, because of their limited range, are among the easiest to reproduce. In any given register, wind instruments produce greater intensities than strings, of which the violin produces the faintest. As a class, these instruments emit notes covering the frequency range of 32 to 4,000 cycles.

From our study of the auditory sensation area we have seen that the ear is able to perceive a large number of tones of different intensity and frequency. We have also seen that the voice and various musical instruments produce tones which cover a large portion of the auditory sensation area. In order to obtain information as to the relative importance of various parts of this area to the sensory characteristics of speech and music, experiments

have been performed in which the tones falling in various parts have been eliminated from the general sounds by means of so-called filters.

When frequencies below 100, 200, 300, or on up to 1,000 cycles are progressively eliminated from speech its character changes markedly. The terms "timbre" or "tone colour" best describe the characteristic lost. This characteristic appears to be associated with the fundamental and the first few overtones of the voiced sounds. Their presence is necessary, therefore, in order to convey this quality; but sound frequencies below 300 cycles do not appear to be essential for the correct interpretation of speech.

When frequencies above 8,000, 7,000, or on down to 3,000 cycles are eliminated, the character of the speech again changes markedly. The term "sibilance" appears to describe best the characteristic lost and refers to the prominence of the hissing or frictional character of speech. If attention is directed to such sounds as *s*, *f*, *th*, and *z*, the elimination of frequencies above 6,000 or 7,000 cycles is readily detectable, but it requires rather close attention to detect the elimination of frequencies above 8,000 cycles. Elimination of frequencies above 7,000 cycles, however, slightly impairs the interpretation of the *s* and *z* sounds of a woman's voice; and elimination of frequencies above 6,000 cycles, those of the *f* and *th* sounds of a man's voice, and of the *f*, *th*, *s*, and *z* sounds of a woman's voice. The impairment due to eliminating higher frequencies is usually greater in the case of female voices.

As in the case of speech, the tone colour or timbre of musical tones also appears to be associated with the fundamental and the first few overtones of the note produced. Timbre is probably more important in music than in speech. For example, it is one of the things that distinguish the tones of various instruments. In general,

therefore, the fundamental and the first three or four overtones are necessary in order to distinguish the tones of various instruments. When overtones higher than these are eliminated the tones lose a characteristic best described by the terms "brilliance" or "definition"; they seem to lose life and to become dull. The prominence of these characteristics varies with the type of instrument, the composition of the music, and the personality of the musician.

The notes which are used most in music are contained in the octaves below and above middle C, or from 128 to 512 cycles. Since the fourth overtone of 512 cycles has a vibration frequency of 8,192 cycles, tones of this frequency, and below, occur commonly in music. A trained ear could no doubt detect the elimination of frequencies above this range from the ordinary run of music, but the average individual would have difficulty in detecting the elimination of frequencies above even 6,000 or 7,000 cycles unless he gave particularly close attention to the percussion instruments.

Another phenomenon of hearing which enters into the sensation of sound is called "masking." The tones of low pitch in a given sound deafen the auditor to the higher tones. The deafening or masking effect becomes quite marked when the sound pressures of the lower tones are greater than 20 sensation units. The optimum loudness for the interpretation of speech corresponds to a sound pressure between 0 and 20 sensation units. If the sound pressure is less than this the fainter sounds are inaudible. If it is greater, the masking effect impairs the interpretation. When sounds are increased in loudness the lower registers are accentuated because of the masking effect; so that, for most faithful reproduction, sounds should be reproduced with about the same loudness as the original.

Practical tests of the hearing of 500 persons have dis-

closed that persons differ significantly in their keenness of function. Further, the test shows that there is frequent disparity in the sensibility of the two ears; that high notes are more readily perceived than low ones; that the upper limitation of audition varies considerably for different normal individuals; and that the hearing of men is apparently better than the hearing of women, but that such difference is very slight.

The reaction of listeners not musically trained is one of great delight in the simpler compositions. When a composition is intricately constructed and requires mental effort the sound is likely not to be pleasant unless the hearer has been schooled in musical appreciation. It is too remote from his normal background. In the same way the degree to which the listener enjoys an unfamiliar work depends upon the degree of its simplicity.

The tone quality of sound, like the pitch, may be accurately measured and may be examined and preserved for comparative study. The principal methods heretofore employed for making such records are the Phon-autograph of Koenig, the phonograph invented by Edison, the telephone of Bell, used in connection with the Oscillograph and the Manometric Flame devised by Koenig and developed by Nichols and Merritt.

An interesting way to study sound waves is to be found in the phonograph. We can make the phonograph disk record the waves corresponding to an orchestra or to any kind of sound, simple or complicated, music or mere noise, and the marks made upon the wax by the needle can be studied by means of the microscope or may be greatly magnified and photographed. In addition to these is the Phonodeik devised by Dayton C. Miller, Professor of Physics, in the Case School of Applied Science at Cleveland. By the use of his instrument it is possible to photograph and measure sound waves, both vocal and instru-

mental. Through the analytical investigations of sound by this method the ideal musical tone for any voice or instrument can be accurately defined and reproduced.

Sound travels only 1,089 feet a second in air at 32 degrees F., the speed increasing a little more than one foot a second for every degree of rise in temperature. We see distant lightning long before we hear the peal of thunder, because light travels so much faster than sound (186,000 miles a second). Sound grows fainter with distance. We can easily understand why this is so: as the sound waves move out from the centre, the original impetus given them is spread out thinner and thinner. A locomotive whistle rises to a shrill shriek as it approaches and dies away to a low, mournful wail as the train departs, even though the whistle is emitting vibrations at the same rate all the time.

The distance of sound is judged by the feebleness of its impulse on the ear. We can readily judge direction in sound, as to whence a voice proceeds—before or behind—or to the right or left of us—or above—or below us—but if we were to stand blindfold opposite a row of persons at a distance of, say, ten feet we would not be able to say which person emitted a given sound.

The influence of familiarity is well exemplified in sound. We can more clearly hear a language we understand than we can a foreign language. It is comparatively easy to catch an utterance in a familiar language, even when very faintly spoken, and in the same manner a familiar voice is more easily discernible than the voice of a stranger. The better acquainted the mental system is with an impression of sound, the more easily is it heard. Thus, a familiar sound or musical composition is immediately recognized, even though heard or played very lightly, whereas an unfamiliar sound or musical composition cannot make the same impression.

Sound has a psychological effect on the brain. A gentle or moderate sound, such as the ringing of bells, is an agreeable sensation, and so is the gradual augmenting or diminishing of sound. The moaning of the wind sometimes has this characteristic. The fading away of sound is especially pleasing to the sense of hearing. Thus sound may produce an emotional condition. Music may arouse as well as soothe. Bugles may inspire just as thunder may terrify. Through sound we can likewise communicate ideas, express pleasure or pain, and distinguish the voices of men, women, and children. We frequently can mark a distinction between large and small bodies, as in the case of the cries of large or small animals.

A bird's song and a pig's grunt are both sounds, yet one is a beautiful musical tone while the other is an unpleasant noise. The difference is caused by the regularity and irregularity of their vibrations. The screeching of a parrot, the shrill barking of a small dog, the screaming of an infant, provide instances of discordant or unpleasant sounds. We cannot bear them, but when sounds are pleasant their multiplication has an agreeable effect on the ear.

Is it possible to determine the difference between singing and speaking? In either case sounds are produced by the means of a voice box, except in whispering. In both cases, these sounds are produced, in a measure, in the same manner. In both cases there are changes of pitch. In speaking we do not keep the same note, even in the shortest sentence. The voice is raised and lowered as we go along, and much is conveyed by the way in which we do this; so much so that the pitch of the notes we use expresses a great deal. To speak steadily in the same note would be monotonous indeed. In addition we use different loudness in speaking and give varying colour to the voice. We speak to a child in a more tender tone than when we are giving orders, even though we may speak more loudly to the child.

There are many different shades of expression, as well as of loudness, which we can put into the same words spoken on the same notes. The singer uses a variety of notes as well as a variety of force and colour. Both singers and speakers use a variety of rhythm and speed, yet there is a decided difference between speaking and singing. When we speak we do not use fixed intervals of musical pitch, but slide the voice up and down and keep the voice within the limits of perhaps half an octave or less; but when we sing the voice may range over two octaves or even more. In singing we use only notes with fixed intervals between them, while in speaking we let the voice rest wherever we please.

To people with sensitive ears there is scarcely greater delight than to be surrounded by others with beautiful speaking voices. A person who speaks in a high-pitched, harsh tone, as if he scarcely expected to be heard, indicates to us something about himself and his surroundings. In contrast let us compare the woman who speaks in a rather low-pitched, quiet, and musical voice. Her tone would indicate that she is accustomed to live in an atmosphere of refinement. Shakespeare makes King Lear say of his daughter, Cordelia:

> Her voice was ever soft,
> Gentle, and low,—an excellent thing in woman.

There are physicians who, because of the kindliness of their voices, appear more efficient and clever than others who are perhaps more talented physicians. We are therefore accustomed to say that the voice may consist of one of many given pitches and of different shades of colour as well.

The moments spent in reading the foregoing pages, quite apart from the interest of the subject as anatomy or physiology, must have revealed several interesting mat-

ters in connection with motion picture production. First of all there is the concrete evidence of how far the producer's scope is widened. Once satisfied to confine his studies to optic function (and there mainly as regarded light and shadow), now he annexes the domain, not merely of speech, but of audition. He is the richer in function and in power. On the other hand, as each fresh acquisition brings its accompanying responsibility, he finds himself a man of redoubled obligation. He owes it to himself to reach out to a larger grasp, because he owes it to the industry and most of all to the public. But I must apologize for saying that either my words or the brief experience of the business "reveals" these things. It might be better to say merely that they "indicate" the fresh opportunities and the fresh burdens. Yet even though what we hold in our hands be less a power than a potentiality, the magnitude of what we glimpse is enough to arouse every energy toward fulfilment, every determination not to rest until we have made the future ours!

Part Four

THE CONTRIBUTIVE FACTORS

CHAPTER XI

ADVERTISING

No DISCUSSION of sound could be considered full and complete without the devotion of attention to the auxiliary matters which make up the present section. With each change in the policy of exhibition there come concurrent adaptations in certain departments and features that contribute much to the life of the theatre. Just as the industry has been concerned with the development of a new kind of central attraction, so it has been busy altering the form of the shorter numbers of the programme. Similarly, since not only speech but music is being synchronized, the place and part of the latter as a factor in the entertainment have had to be submitted to inquiry from new angles. What has been done—what remains to be done—in both of these connections I intend to explain in the twelfth and thirteenth chapters.

Before going to those topics, however, I wish to take up the matter of that prime auxiliary of the film—advertising. This crier of our purposes, our ready and eager spokesman from the first days of our history, has a place of importance in all our ventures; for advertising is vital to the screen in every direction and fashion. It not merely announces our wares, it not merely wins us patrons, but it voices and interprets our ideals. In the last connection its function for the exploitation of sound has already proved its value to be constant and indispensable. It has in most cases risen to the need of the hour with all its old usefulness and refurbished and revitalized all its old armoury

of devices. When it has been called upon to invent new resources it has done so, and has in general maintained all its powers as the breath of distribution and the tongue of the trade.

In many respects, of course, advertising for the theatre remains what it was before sound arrived. It was, then, a kind of profession in itself, subsidiary, but highly developed and organized. Its departments, its methods, its place I have already told in the twenty-fifth chapter of my earlier book, *Motion Picture Theatre Management.* There the reader, if he wishes, may find them treated in a manner, I believe, still serviceable in essentials. Consequently I shall risk no repetition here, except to say again, with undiminished emphasis, that no adjunct of the screen contributes more to its success.

The newer features or attitudes or slogans that publicity has evolved to meet novel conditions will therefore be my text here; and from the wish to provide concrete benefit in information, I will present some examples verbatim. The reader will therefore see with his own eyes what the trend has been, and local management will be provided with actual models upon which to design publicity for home consumption. Already, moreover, some principles of procedure have evolved from experience. These I shall take up first, for the sake of whatever background they may provide, so that particular illustrations shall stand out boldly.

Now that the sound picture is accepted, the public is not interested in the novelty of attending a performance, but rather in the entertainment value that is offered. It is important, however, to designate in all advertising the type of sound entertainment, and to express clearly the vital features of the category into which the particular type of synchronization falls: all-talking, synchronized score, or singing and talking, as the case may be. So far as

patronage is concerned there is undoubtedly very little distinction among the designations of the different types of sound-recording apparatus. Beyond the fact that the trade names "Fox Movietone," "Vitaphone," and "R. C. A.-Photophone" have been widely advertised, it is questionable what significance, if any, they may possess in publicity. They surely do not tell the public the form or proportion of sound that will be heard. "Sound Picture" is the general title used throughout the industry to describe a film synchronized with sound, but it is not sufficient for advertising purposes. The kind of synchronization should be clearly advertised so that the public may determine the differences. It is wrong, for example, to advertise a picture with mere sound effects or with a musical accompaniment as a "talking picture."

In designating the different kinds of synchronization the aim should be to make the patron understand that some productions have greater value at the box office than others. It is unethical to misrepresent. Eventually such duplicity will act as a boomerang and will result in loss of confidence. To advertise a film that contains musical accompaniment as a "talking picture" is absolute misrepresentation.

Every progressive element in the industry realizes the danger. Therefore we have recently classified the various degrees of synchronization. The classification removes any difficulty by making it very clear to the motion picture public just what they may expect to hear. In the first group we have put talking feature motion pictures, which are of feature length and contain dialogue. In the beginning there were some films which contained talking sequences, while others were all-dialogue pictures. It was in connection with these that confusion in exploitation arose. A talking motion picture which contains talking sequences should be advertised with the phrase "containing talking se-

quences," in order not to lead the public to believe that an all-talking picture is being presented. For the latter category the best line is "a 100 per cent. all-talking picture." This carries the message definitely and with clear understanding.

The next classification covers sound pictures, without dialogue, but containing singing voices, sound effects, etc. Such films have synchronized scores and contain singing, or perhaps sound effects, such as the whirr of the airplane, the report of guns, the clamour of crowds. In all such cases the sound element naturally may be advertised, and a phrase similar to "with musical accompaniment and realistic sound effects" may be of value.

The "talking news" is a clear designation. It is self-explanatory. The Fox Movietone Talking News has become well known wherever sound motion pictures are shown. It exploits current events so that they may be seen and heard, and is of great value, not merely because it brings to the screen personalities that appear as though in the flesh, but because it is so human and natural. It shows, on the screen, such simple matters as ducks quacking, a rooster crowing, children swimming in an "old swimmin' hole," automobiles roaring around race tracks, or a Lindbergh taking off, and thus brings into the auditorium subjects that have strong audience appeal. Sound has endowed the news reel with a greater importance than ever before, and if the fullest value is to be obtained this feature of the programme should be properly advertised. Naturally, it should be advertised by its full title, emphasizing equally the two words "Talking News." In addition, each important personality or event should receive added mention, and the whole should be heavily billed with the words "See and Hear."

Another important classification is that of talking and singing short subjects. These consist of different kinds of

entertainment, such as vaudeville acts, sketches, miniature musical comedies, vocal soloists, or instrumentalists. Such attractions should be advertised along lines similar to the talking news, with emphasis on the "See and Hear."

The final classification is that of musical synchronization, which, while of genuine importance in itself, is the type that has generally been most misrepresented. Such motion pictures are accompanied by musical scores, synchronized to the action of the story. They contain nothing else. It is needless to point out that advertising must not claim any more for them than that. When properly conceived, musical synchronization is of great help to the enjoyment of a feature motion picture and thus may legitimately be emphasized in advertising.

Naturally, when "sound" installation has just been made in a theatre, the first and most important problem is to advertise and "sell" the installation of the equipment and the inauguration of the first programme. To do this in the most effective manner requires a carefully planned campaign with one object in view—that the public be told that your screen will on a given date talk or sing or both. The campaign may profitably be modelled along lines similar to that of inaugurating the opening of a new theatre or of the celebration of an anniversary. In order to get the best result every publicity medium should be used. Efforts should be exerted to secure the fullest coöperation of the newspapers, and to develop, perhaps, a special section by securing coöperative advertising with transportation lines or by any other means that may be available. The plan must of course be based on the fact that the copy shall sell the talkies first.

All that the public is interested in, after that, is the entertainment value. They do not care how the phenomenon is brought about any more than they are interested in the specific operation of a radio set. Only those

who are mechanically inclined are curious about the technical phases of sound apparatus, and they have methods of their own for procuring such information. Technical copy can only confuse the public. It is of no real interest to them, and may only create the impression that sound synchronization is another type of "canned" music or phonographic device. Therefore it would appear best to eliminate any technical description of sound devices. If the screen talks and sings, say so; say who and say what; and use all possible advertising channels enthusiastically and forcefully.

A specimen campaign that has been successful I submit, in outline, as follows:

Specimen Campaign

Note: *Use the expression "See and Hear," or "Our Screen Will Speak and Sing," and similar copy, as explained later in this chapter.*

1. A four- to six-week "teaser," on the screen, the programme, the house banners, or in advertising underlines.
2. A special coöperative section in newspapers, with copy secured from local merchants.
3. Circus heralds on "See and Hear" in connection with personalities that will be thus presented.
4. Banners and posters on "talkies" placed wherever possible in the lobby and the theatre front.
5. One-sheet "See and Hear" material in every available vacant store window.
6. Banners at important street intersections and in hotels.
7. Window cards in windows of music stores, featuring songs that will be heard in first few sound shows.
8. Coöperative copy on mirror signs, mention on menus, in soda fountains, restaurants, etc.
9. Photographic and lithographic cutouts of personalities

to be "seen and heard" at the inaugural, including those in the news weekly and short subjects, placed in the theatre, in lobbies, in windows, at bus stations, at railroad stations, and at street-car terminals—all with names and prominent "See and Hear" captions.

10. Signs for rear-wheel caps on cabs.
11. Banners for bus lines.

OUTDOOR POSTING: 1 sheets, 3 sheets, 6 sheets, 24 sheets, window cards, banners, street cards, bus or auto cards, and all sniping.

Next to newspapers, outdoor billing of sound attractions, of course, assumes the greatest importance. The best advice for outdoor posting, since the copy must be short, is that the following words be used: "See and Hear" or "Talking Pictures," in connection with any attraction in which there is talking or singing. After the policy has been established other catchlines can be used. Phrases like: "This One Speaks," "You Will Hear John McCormack Sing," etc., may be used with telling effect. The phraseology can be changed to the extent of saying: "You'll See Him and You'll Hear Him," or "You Hear This as Well as See It"; but such copy must be at least as prominent as anything else on billboards or in newspaper advertising.

The following is a series of phrases, catchlines, and slogans offered as examples for general use, not only in newspapers, but for lobby cards, banners, signs on trucks or cabs, teaser ads, teaser trailers, window cards, 1 sheets, 3 sheets, 6 sheets, 24 sheets, restaurant menus, heralds, programmes, etc.

They may be used in advertising the Inaugural, the Talking Feature Picture, the Talking News Weekly, and Talking and Singing Shorts. The lists that follow this one are to be used for pictures that have no dialogue but contain voice or other effects, and with pictures which have only orchestral synchronization.

Catchlines for an Inaugural, for Talking Feature Pictures, Talking News, and Talking and Singing Shorts

See and Hear!
Hear! Hear!
Hear! Hear! Hear!
Hurry and Hear It!
Come and Hear!
Eye and Ear Entertainment!
Sight and Sound Sensation!
They Talk!
Our Screen Speaks!
A Perfect Wedding of Sound and Sight!
Look! Listen!
Have You Heard the News!
Now You Can Hear the News!
The Best from Broadway, and You Can Hear Them Here Next Week!
See and Hear 70 Minutes of [name of celebrity] Voice [or song or songs] and All in [name of picture] with [explain whether Vitaphone or Movietone, and accompaniment, if any].
Come On, Los Angeles, This One Speaks!
See and Hear the Last Word in Talking Pictures!
A Drama in Dialogue!
Look Whom You Will Hear Talk!
Your Eyes Will Live . . . Your Ears Will Love [then details of show].
Our Screen Has Come to Life . . . to Golden Voice . . . You See and Hear It!
Hear Golden Voices Added to the Silver Screen!
The Silent Screen Is No Longer Silent—It Speaks!
See What You Hear! Hear What You See!
Hear It, Cheer It, See It, Love It!
The Last Word in Sight and Sound Entertainment!
They Came Thousands Strong; They Saw, They Heard!
They Saw the Stars and Heard Them, Too!

The "Talkies" Are Coming! [or "Are Here!"]
Titanic Talking Triumph!
The [name of theatre] Screen Speaks—See It! Hear It!
You Hear What You See!
Poured from the Throat of the Screen to Add Sound to Your Eyes!
A Silent Drama Endowed with Life!
Our Screen Speaks [or Cheers or Laughs or Sings]!
The Age-old Dream of Pictures that Speak Comes True!
New Beauties for the Eye—New Delights for the Ear!
Vitaphone [or Movietone] Presents Broadway's Brightest Star for You to See and Hear!
Our "Talkies" Are the Talk of the Town!
Terrific Underworld Drama [or Comedy, as the case may be] with the Added Thrill of the Human Voice!
Sensational Eye and Ear Entertainment!

Catchlines for Sound Pictures without Dialogue But With Voices of Some Other Sort, or Effects

Hear What You See!
Hear! Hear!
Eye and Ear Entertainment!
Sight and Sound Sensation!
A Perfect Wedding of Sound and Sight!
Look! Listen!
Gloriously Set to Golden Sound, with Voices and 110-piece Roxy Theatre Orchestra on the Movietone Accompaniment!
Your Eyes Will Live! Your Ears Will Love! [Then details of show.]

Catchlines for Mere Musical Synchronization

And you'll hear the wonderful Roxy Theatre Orchestra of New York making the screen live for your ears, on the MOVIETONE!
Miracle Movietone musical accompaniment by the great

Roxy Theatre Orchestra of New York City . . . 75 men playing!

Bringing to your ears the marvellous musical score played by the 75 musicians of the Roxy Theatre on the Movietone!

Gloriously . . . gorgeously accompanied by 110-piece Roxy Theatre Orchestra on the FOX MOVIETONE!

And you'll HEAR the great Rapee conduct a 110-piece symphonic orchestral accompaniment on the FOX MOVIETONE!

NOTE: *When a musical accompaniment is the subject advertised, what is significant should be singled out: the conductor, the size or the reputation of the orchestra; or phonograph record fame.*

CATCHLINES ADAPTABLE FOR PERSONALITY PRESENTATIONS

Below is a series of catchlines, used in Los Angeles in advertising Jolson's Vitaphone production *The Jazz Singer*. They fit, perhaps with a change here and there, any personality, either singing or speaking, and in any kind of a picture, and are adaptable for all media:

Next Wednesday! Première of Premières—The Great Theatrical Sensation!

World's Greatest Entertainer in the Greatest Show of his Life! New Songs and old favourites sung by Mr. Jolson during the action of the story on the Vitaphone.

Will Rogers in the hit of his hit-packed life!

To-night! The sensation of the whole show world in a glorious première of stars and lights!

Will Rogers in the movies now . . . movies that you HEAR!

Jolson's in the movies now . . . he sings . . . old songs . . . new favourites . . . he talks . . . he acts . . . and how! It's the hit of his hit-packed life!

It was gorgeous . . . last night they cried . . . they laughed . . . they shouted . . . Al himself broke down and wept.

. . . But you ain't seen nothin' yet. . . . Here is the Greatest Show of his life!

Read any paper in town . . . read what the critics say. . . . The hit of his hit-packed life . . . the rave of the year!

All of Jolson . . . as you've never heard before! That sob . . . that voice . . . those eyes . . . and all his best songs. . . . See and hear him!

Better than Jolson himself . . . Jolson's in these movies that you hear!

Hear and see . . . his personality . . . his magnetism . . . his best songs . . . his comedy . . . his patter . . . his drama . . . as you never heard before!

The unquestioned hit of the year . . . that's——

Lenore Ulric's in the movies now . . . and how! . . . Songs . . . sobs . . . laffs . . . and all!

All of Jolson . . . more of Jolson, and a better Jolson than you've ever heard before!

Two hours of Jolson . . . more of him than you ever heard before!

Two hours of Jolson's best. . . .

See and hear two hours of Jolson . . . the picture with voice and soul!

Spend two hours with Jolson! Hear him! See him! Voice, sobs 'n' all!

If you think you've heard Al Jolson . . . you ain't heard nothin' yet until you've seen and heard——

See and hear the World's greatest entertainer!

The perfect talking picture . . . Jolson's voice perfected on the Vitaphone! . . . Makes you forget you are seeing a picture . . . sweeps you into drama or amazing soul-power!

Will Rogers in the perfect talking and singing picture . . . hear him . . . laugh with him . . . cry with him!

Two hours of the world's greatest entertainer . . . singing . . . talking . . . playing on the perfected Vitaphone . . . the World's Eighth Wonder!

See! Hear! Laugh! Cry! Two hours of the voice . . . the sobs . . . the comedy of——

Jolson out-Jolson's in the movies. . . . Hear! See! Laugh! Cry with him!

Jolson makes the movies sing . . . and how!

Hear Jolson sing his best song hits in the action of this powerful story.

With a voice and soul! and Vitaphone giving soul . . . voice . . . life to the screen. . . .

The miracle of the day. . . .

Jolson . . . speaking . . . sobbing . . . laughing . . . crying . . . his best songs . . . a wonder story!

Come . . . hear! The silent screen speaks! Come . . . sob and laugh! See and hear two hours of miracles!

You hear Jolson! You see Jolson! You love Jolson! Two hours of him!

Come back stage for two hours . . . see, hear, and feel Jolson!

The perfect talking picture . . . when you hear him you'll forget it's a picture!

Tears and laffs! Laffs and tears! Everywhere conceded the most extraordinary entertainment ever offered!

See and hear . . . Al Jolson . . . before it's too late!

The magic of Jolson. . . . Two hours of him!

Two hours of "Big Boy." . . . Now . . . the "Big Joy" of the screen!

150,000 people have walked more than a mile to see and hear Jolson!

We repeat . . . you ain't seen nothin' yet . . . until you see and hear——

Celebrate with "Big Boy"! See! Hear! Two hours of the world's greatest entertainer!

See! Hear! Thrill! Throb! Two hours of Al Jolson!

Mammy's favourite son. . . . Hear! See! Two hours of him!

Hey! Hey! Los Angeles . . . the Big Boy . . . the Big Joy leaves soon!!

For Mammy's sake . . . see and hear! Two hours of the Big Boy!

Absolutely unpardonable to miss this "Big Boy-Big Joy" show!

Sound trailers have been, and will continue to be, a valuable adjunct in advertising sound motion pictures. A new field of trailer advertising has been developed by the various studio publicity departments in connection with sound pictures. These are specially produced from a miniature scenario enacted by featured players of the cast. Many of these are quite entertaining and are a splendid medium of publicity for the forthcoming attractions.

The following are sample trailers giving an idea of the advance screen copy which can be used to advertise the coming of the various types of synchronized pictures as well as those suitable in announcing the inaugural of a Sight-Sound policy. Excerpts from the other trailers may be added, designating the particular kind of sound attractions of the opening programme, and along similar lines, in advertising a programme which includes more than one of the five different categories of sound.

Such trailers should be used a week or two in advance of the actual opening. In addition to these a series of introductory and teaser short trailers are of value.

BARNUM . . . HIMSELF . . . NEVER ANNOUNCED
ANYTHING BIGGER THAN . . .
this epochal event in the entertainment history of [your city or town] . . . the realization of the age-old dream of motion pictures that SPEAK!

FOX MOVIETONE TALKING NEWSWEEKLY:
WARNER BROTHERS MARVEL VITAPHONE PRODUCTIONS

[or whatever synchronization you will have] will be yours as a regular part of the entertainment offered here starting [date].

This contribution of science endows motion pictures with SPEECH . . . affords wonderful musical settings . . . brings

world-renowned artists for you to SEE AND HEAR . . . in a perfect wedding of SIGHT AND SOUND!

You HEAR and SEE all; the motion picture world on parade . . . the world in action passes in review . . . in triumphal scenes that you HEAR! HEAR! SEE! SEE!

You will find in the FOX MOVIETONE TALKING NEWS-WEEKLY and WARNER BROTHERS VITAPHONE PRODUCTIONS the Aladdin's lamp of Modern Entertainment programmes. . . . THE LAST WORD IN MOTION PICTURES THAT SPEAK AND SING!

The following type of copy is for use in introducing Movietone or Vitaphone in your town when your first production employs dialogue partly as in Fox's *Air Circus*, or Warner Brothers' *Caught in the Fog:*

On [date].
The Treat of Treats!
The Hit of Hits!
The——Theatre
FIRST TALKING PICTURE!

The [name of theatre] "goes talkie" with that next show. The whole city has been waiting for this moment. It will be the —— Theatre's first word and the city's last WORD in TALKING PICTURES!

Our FIRST TALKING PICTURE will be [name of picture and name of producer]. Scientifically perfected [Movietone or Vitaphone] production. . . . You'll HEAR AND SEE it! You'll HEAR [name or names of stars] . . . in an all-speaking cast. . . . You'll SEE AND HEAR a superb comedy-drama [or whatever it may be]. . . .

DON'T MISS THIS POWERFUL . . . DYNAMIC DRAMA IN DIALOGUE! THIS "TALKIE" INAUGURAL THAT WILL BE TOWN TALK! at the

—— Theatre [date] . . . from now on the Eye-land . . . Ear-land of Enchanted Entertainment!

The following is a trailer copy for use in advertising pictures employing sound effects, such as *Wings*, which has no dialogue:

The —— Theatre, "The Home of Big Pictures," has arrived! Has come into its own! With the finest SIGHT-SOUND Policy in America.
You will SEE and HEAR [——] at the —— soon. . . . Presented with synchronized Sound effects that bring you the roar of motors . . . the put-put-put of machine guns . . . the anguished cries of stricken pilots . . . the terrifying crash of cracked-up planes . . . all this . . . and more . . . that keeps you atop your seat . . . your blood tingling and your heart thumping.

(*To be used if you also have News or Shorts*)

and all this with SOUND EFFECTS . . . and always . . . sparkling SIGHT-SOUND NOVELTIES including the FOX MOVIETONE TALKING WEEKLY.

You'll HEAR an exquisite musical score by the 75-piece Paramount Theatre Orchestra of New York City.

You'll HEAR and SEE it all . . . the thrill of this magic age next [date] . . . [Theatre] RICHARD DIX in *Warming Up* . . . Paramount's first in SOUND.

The following type of trailer is for use where SOUND-SIGHT Synchronization is employed with effects but without dialogue, such as William Fox's *Street Angel*, *Four Sons*, or *Fazil:*

AND NOW! AT LAST!
The Eighth Wonder of the World!
The Thrill of Thrills!

The hit of all-time hits!
The cinema rave of raves!
DIRECT TO YOU . . . in all its SIGHT-SOUND GLORY . . .

Hailed as the outstanding SOUND EPIC OF THE SEASON with tremendous casts . . . gloriously embellished by the massive . . . 110-piece Roxy Theatre Orchestra of New York City.

And you hear marvellous singing . . . scientifically attuned to embellish the sparkling action of the picture brilliantly . . .

OUR SILENT SCREEN ISN'T SILENT ANY MORE!! YOU HEAR IT! IT SINGS! MIRACLE OF MIRACLES! THE WEDDING OF SOUND AND SIGHT IS NOW YOURS . . . at this theatre.

[Name of picture] is one of those two or three pictures that may justly be described as BIG . . . and BIGGER . . . because you HEAR and SEE . . . golden voices . . . and the marvellous music of America's greatest artists.

The next is a type of trailer used in introducing Fox Movietone Talking News-Weekly or Movietone or Vitaphone (that is, talking and singing) shorts:

IT WON'T BE LONG NOW! before this theatre will proudly offer its patrons Current Events to SEE and HEAR! [or, "The World's Greatest Artists to SEE and HEAR"] coming as a distinct innovation in modern theatricals . . . a "step ahead" . . . from the silent drama . . . which isn't silent any more. . . .

FOX TALKING NEWS WEEKLY. It will bring the world of current events to your doorstep. . . . You SEE the characters in action and what's more . . . you HEAR them! [or, "It will bring the best from Broadway, the cream of vaudeville brilliancies, the best beauties from beyond, the

most marvellous of musical comedy favourites . . . all to you . . . and what's more . . . for you to HEAR!]

This amazing miracle, prophesied thirty years ago, is no longer a dream . . . IT'S A REALITY! THE FOX MOVIETONE TALKING NEWS [or Movietone or Vitaphone] gives immortality to the magnetic personalities of Lindbergh, Coolidge, Mussolini, Hoover, the Prince of Wales, Al Smith [or, "to the golden voices of Al Jolson . . . Marion Talley . . . Van and Schenck . . . Raquel Meller].

It's a magical step forward in entertainment progress . . . and it is yours to enjoy as a regular feature at the [——] starting [date].

In the exploitation of sound pictures, the sky actually is the limit. Every channel or type of advertising or of exploitation fits sound pictures just as it does silent pictures, *providing SEE and HEAR copy is included as the most prominent part of the message or the display.* Any exploitation which makes clearer to the public the fact that your screen will speak or that you will have in your theatre *audible* events, is a good bit of exploitation for sound pictures. Some examples will be of interest. First, an enormous moving van circulates with a big sign on each side, reading: $50,000 in MODERN ENGINEERING MIRACLES ON THE WAY TO THE STATE THEATRE SO THAT YOU CAN HEAR THE STATE SCREEN TALK AND SING. [Don't show any machinery.] Second, any circulating contraption in which is placed a radio receiving equipment with a loudspeaker, or a phonograph that can run continually, and that can be heard as it passes down the streets, with a message emblazoned on the sides reading: "THIS IS AN EXAMPLE OF WHAT YOU WILL HEAR FROM THE STATE SCREEN"—will get your message over. Third, tests by psychologists from your local schools can show how much better emotions may be conveyed by the ear than the eye; tests to see if blindfolded people can recognize the stars on the screen

by their voices; and so on, *ad infinitum;* all make good newspaper copy. Fourth, if a radio station is available, the mere announcement that your screen will speak is enough. More if you can get it, of course; but more along the same lines.

Fifth, in advertising prominent personalities who have made phonograph records the entire channel of music and record dealer tie-ups, of windows, of dealer's coöperative ads, or phonograph playing, and of cut-outs is available and should be used just as though the star were appearing in person at your theatre.

Sixth, a Hoover, a Lindbergh, an Al Smith, the Olympic Games, a football game, a World's Series baseball game, must be advertised prominently in the press, in stories, in the lobby, the marquee, on flags, on the radio. They'll all mean money. Exploitation for them will not be so easy, but the message must be gotten over . . . and orthodox channels will usually have to do. In the case of football and baseball games, watch all clubs (principally athletic) and schools.

In marquee and lobby announcements we may use copy similar to the catchlines that fit the situation. Every lobby card should feature: "See and Hear" or words to that effect. Marquees should be covered with "Talking Pictures" and "See and Hear" copy. A novel way to make up a lobby card is to have phrases lettered in panels issuing from the mouths of the persons pictured. This tells the story at a glance. A loudspeaker or a phonograph in the lobby, coupled with the right kind of big placard with "See and Hear" or "Talking" copy, gets the message over very well.

In preparing publicity for newspaper stories the suggestion is again offered that the writer should not be tempted to indulge in technical copy in connection with sound pictures. It may be wiser to talk about the fulfilment of the new science and the expense of the installation; about the miracle of adding the golden voice to a silver sequence;

PLATE V-A. SPECIMEN ADVERTISING

PLATE V-B. SPECIMEN ADVERTISING

about the individuals who will appear and speak; about the effects that will be heard.

Every motion picture production of itself suggests good publicity material, and though it isn't advisable to give the story in synopsis form and thus destroy the suspense, yet certain high lights may be touched upon and converted into interesting reading matter. Any good personality can likewise inspire plenty of story material to the imaginative writer. The following is a sample of the type of copy that may be used in connection with a 100 per cent. dialogue picture offered in a theatre for the first time:

The 100 per cent. talking motion picture has arrived at last! Its coming was inevitable. And so, for the first time, patrons of the —— Theatre will hear as well as see *The Broadway Melody*, the all-talking Metro-Goldwyn-Mayer production, when it opens its engagement on ——.

This newest of screen marvels brings life to the screen. You hear the characters talking, laughing, singing. You hear the orchestras in the cabaret scenes. You hear every dialogue as spoken.

One of the outstanding features of the picture is the synchronized musical accompaniment to the picture by a 100-piece symphony orchestra, bringing you the best in orchestral music.

Talking pictures are the rage of the country to-day. Theatre after theatre in every state of the union has been wired to take care of the "talkies." Installing the equipment necessary to show Fox Movietone Follies in the —— Theatre has been costly. No effort has been spared to give the people of —— the latest pictures.

Sight-Sound pictures have come to stay. They are the logical outgrowth of the development of the motion picture industry. The best minds in the industry are now trained in their direction. It has taken years for

the "talkies" to reach their present state of perfection.

Sound adds to the audience's enjoyment of the picture. Written titles are not needed, as the action of the story is carried by the voices of the players. Further marvellous developments are looked for—chiefly in the matter of bringing great stage talent to the screen.

For the thrill of a lifetime see the all-talking, all singing, all dancing picture, *On With the Show*, starting on —— at the —— Theatre.

The following is a type of copy that may be used in connection with a short-reel dialogue comedy:

It was but a step from the talking feature picture to the talking two-reel comedy. And such a comedy has been produced and will be shown for the first time in —— at the —— Theatre, starting ——. It is called *The Family Picnic*, and it created a furore at the famous Roxy Theatre, New York City, where it had its world première.

The comic element of this William Fox two-reeler is emphasized with the coming of Sound, the voices of the players, and the other audible effects.

The talking two-reel comedy has a decided advantage over its silent brother. Necessarily speedy in action, these short subject comedies are crammed with action, most of the humour of which was lost when sound was absent.

Incidentally, *The Family Picnic* is the first all-talking two-reel comedy. In that respect it creates motion picture history and will gain a permanent place of honour in the annals of the screen.

The feature picture on the —— Theatre screen will be, etc.

The following is specimen copy that can be used in connection with a Talking News Weekly:

It speaks for itself . . . Fox Movietone News . . . will flash for the first time upon the screen of the —— Theatre next week. This new scientific marvel that brings the sound of the world events to your ears along with a view of them to your eyes, has, in a short time, become the sensation of the show world.

No longer are the intrepid news reel photographers satisfied with a photograph of the President making a speech, with a scene of a football game, or with a view of a pageant in a far-away land. They come now with the voices of famous men and women as well, with the roar of the crowds, the shrill whistle of the referee, and the jargon of distant tongues.

Fox Movietone Talking News Weekly will be a permanent figure of the —— Theatre's screen. It is the very last word in entertainment. It brings to you the world's sights and sounds. It will sweep you away with its startling nearness and make you believe you actually are at the scene where the picture is being taken.

There is no motion picture field in which sound and voice more perfectly fit than in the News Reel. Millions throughout the country, who heretofore have had to be satisfied with only seeing the President, Gene Tunney, Pershing, and other world-famous characters, now will hear them speak with a clarity that leaves the listener amazed. The roar of a battleship's guns, the hum of airplanes, the umpire's cry—all of these are now the rich heritage of the movie fan. They will bring the world to your doorstep. They are the closest thing to actual travel that the human mind has ever been able to conceive.

The talking news weekly starts on —— at the —— Theatre and will continue there indefinitely.

In Plates V and VI, there are shown a number of advertisements which have successfully been used in various campaigns.

Finally, under the heading of "exploitation," many

novel stunts that are attention-attracters have been tried with some success. A mystery picture suggested a striking idea that helped to create additional interest in the presentation. After the regular trailer in this theatre had been shown the screen curtains were drawn and the auditorium was thrown into absolute darkness. A small green spotlight was directed across the stage slowly from the projection room. An announcement was then made by microphone attachment from the manager's office that the *Green Mystery* was coming to that theatre next week. The announcement was made in a very dramatic tone to the accompaniment of soft organ music.

Another attractive use of the microphone is to place one, attached to the sound reproducing equipment, on the organ console, where the organist either sings or speaks the words of a song as he plays his instrument. When done properly this can be very effective. Similarly, loudspeakers arranged in the lobby, under the marquees, in lounging rooms, may be used to good advantage in entertaining a waiting audience. The use of the microphone suggests many unusual opportunities for initiative along such lines. For example, broadcasting stations have been of value in exploiting sound motion pictures. Instrumental selections on the programme, including theme songs of the feature, may be intermingled with announcements over the radio.

Earlier in this chapter I stressed honesty as the censor of advertising for sound. In doing so I was moved by consideration of the fact that there had already been many instances of ambiguity, if not downright duplicity. The anxiety and confusion that attend introducing a new thing to the market have brought such regrettable accompaniments once more; so my wish was to strike a warning at once. Hence I have postponed to this page the mention of something far more vital. Within the limits of good taste advertising for sound, as for any commodity, should

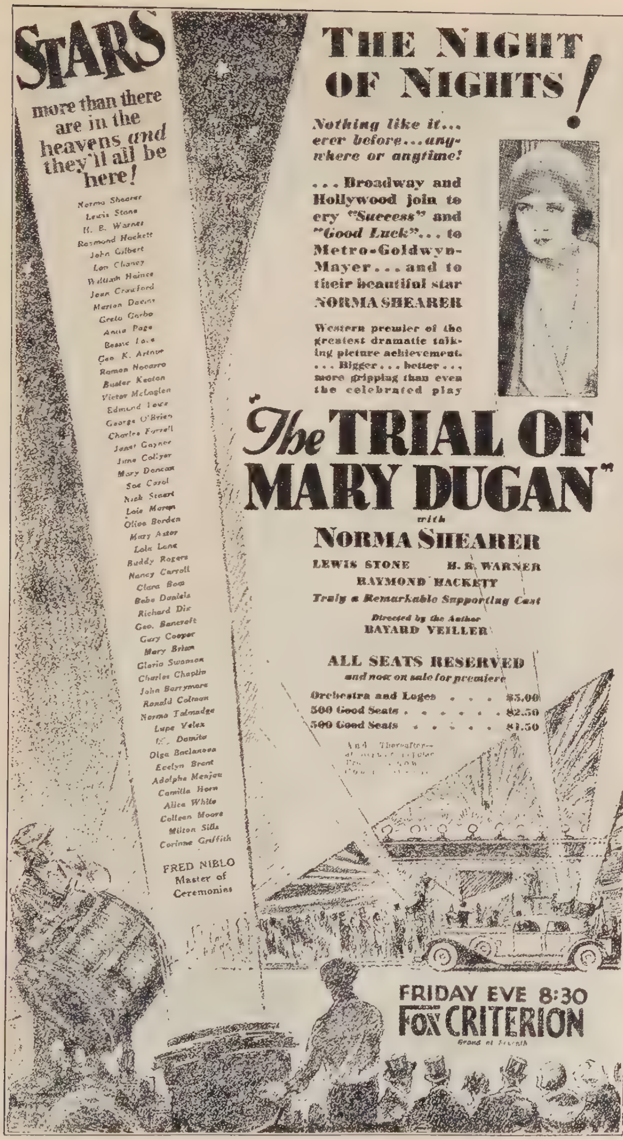

PLATE VI-A. SPECIMEN ADVERTISING

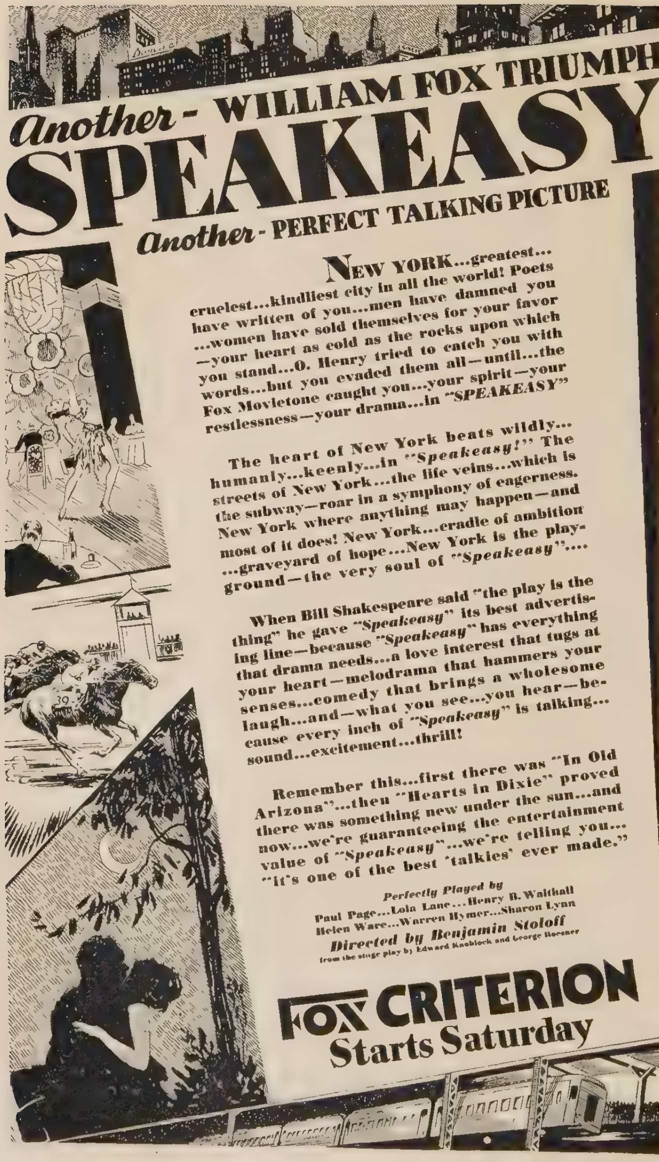

PLATE VI-B. SPECIMEN ADVERTISING

vibrate with enthusiasm. It should draw upon every ounce of inventiveness and vivacity in the advertiser, so that it may arouse and magnetize the greatest possible number with its infectiousness!

Finally, I must not forget to say that of all publicity the best sort is that which *belongs* to a house because of what the public gets there. In connection with sound this means clear and pleasant reproductions for eye and ear. It means good equipment, ideal acoustics, and the right films. The press, the ballyhoo, the lobby may bring in the crowds. The performance will hold them, bring them back, turn them into well-wishers, and make them speak for you. There is no advertising that can down a bad reputation; there is no advertising like a good one.

CHAPTER XII

MUSIC

Has the advent of sound affected the position of music in the motion picture theatre? Decidedly—and for the better! Nor am I thinking of musical synchronization, as such, alone. The result in that direction is known to anyone who has attended a handful of performances. Indeed, my mind is running off to the thought of how the level of appreciation is rising all over the country, what with the "transportation" of the best metropolitan orchestras to every town and village. I am conscious, too, less of present performance than of the future vision of a nation of music lovers trained by the leaders of our industry.

Yet I must not run too far ahead of my story. If the public is to grow richer in understanding and enjoyment we must provide the means; and if we are to do that we must know how. Here, as elsewhere, new power brings new duties; we must go to school again, to learn what we may, not merely of the procedure of propagating the beauties of this art, but of the A B C of the art itself. So a brief inquiry in that direction may not be amiss.

Sound is the principal medium through which most of the higher animals both express and excite emotion. As a warning or a menace sound is a cry of instinctive self-preservation. Melody is the art of sound, and every emotion may be expressed through it: joy and sorrow, fear and longing.

Music, in the largest sense, is made up of three elements:

rhythm, melody, and harmony. The first two may be traced to the very beginning of human consciousness itself. In those who love music we therefore find three corresponding levels in the lowest aspect, the discrimination of one sound from another; in the second, the recognition of melody; and, in the highest, the appreciation of harmony. The Negro and the gipsy, for example, had originally the faculty of appreciating only melody, but lately have learned to recognize harmony as well.

It is a general fallacy that imagination is necessary for an appreciation of music. Since we find this function conspicuously weak in many nationalities who love music it can readily be seen that the belief is unfounded. It is only necessary to name as instances the American Indian, the Australian Bushman, and the Negro races in middle Africa. In fact, scientific investigations made by psychologists prove that even wild animals are affected to a degree by tones. We have the example of the cobra and the snake charmer, or that of the belated violinist who is supposed to have averted an attack of wolves until morning by playing his instrument!

There are, likewise, differences of degree in the appreciation of music by different persons, just as their faculties may differ in other mental activities. One musician may hold in high regard the works of a certain composer, and yet dislike the works of another. The variations found in persons as to the character of the music they enjoy most may be traceable to psychological peculiarities or discrepant mental development. An individual who is patriotic loves martial airs; another who is religious prefers sacred music. It is a curious psychological fact that optimistic persons prefer slow, weird, and melodious music; while pessimistic minds are partial to light, quick harmonies. For some people music has a tremendously stimulating influence upon the mentality;

and with those who are in a depressed mental state it is but natural that light, quick airs should lift the spirit out of its gloominess. Music is often responsible for acts of bravery upon the battlefield, just as it occasionally may be the cause of fits of depression. This is due to the influence of the surroundings. No illustration could be better than that of the mental effect of the music of the wedding march at a nuptial or of a funeral march at a burial. Both airs are symbolic of what they represent, with the mind, of course, in a state of receptivity. Just as black to the sense of sight seems to suggest an associated unknown, and consequently a feeling of fear, so centuries of racial experience have associated orange and light colours with sunshine, life, and hope.

The same statement holds true for the sense of hearing, since the noises made by the wind in dead of night find the mind peculiarly alert to impression, which is neither more nor less than a latent mental inheritance that speaks of danger. The same symbolic conscious or unconscious interpretation takes place in music, which is an attempt to stir an emotion that is latent in our sensibilities. This generalization may be proved by the fact that minds are affected by music as by no other sense impression.

A musical temperament is nothing more than the mental penchant found in some individuals in connection with the enjoyment or exercise of the auditory sense. Such people are responsive to impressions, but their leaning may best be described as a state of mind. Through the expression of music all emotions appeal to them, and in turn they try to depict their emotions by means of melody. The phenomenon is not unlike those of other individuals who look at life's realities chiefly through one sense of impression: the painter viewing and enjoying existence in the expression of his art, and the glutton enjoying all the raptures of the world by means of his sense of taste.

There is such a thing as overdoing the musical temperament, as is evidenced by excess attention to every sound, and by attempting to locate each properly in the scale. Some souls indulge in constant whistling or humming in the endeavour to express every stray thought as a musical tune. Such individuals are apt to build beautiful day-dreams and are constantly disturbed by discordant noises, which bring them nervousness, but which to the normal man bespeak life, bustle, and progress and are therefore music to his ears.

The expression of music may be made through either song or instrument. Both forms are quite ancient. The various instruments of the orchestra may all be traced to primitive devices. If you stretch a string or wire tightly and pluck it, it vibrates, giving forth a pleasing sound. If you close one end of a hollow tube and blow into the other, the air in the tube is set vibrating, with production of a different sort of sound. If you strike a thin piece of skin stretched over a box, or a piece of metal suspended by a string, they cause still different kinds of sound. From these three modes of creating sounds come the different kinds of musical instruments that we have to-day; for upon close examination, every type of musical instrument is seen to belong in one of the three groups. Those in which the sound comes from vibrating strings are known as "*string* instruments"; those in which a column of air is set in motion are called "*wind* instruments"; and those that vibrate by being struck are called "*percussion* instruments." Of the three groups the strings are the most numerous, and the piano is the best known. The harp has almost as many strings as the piano; but these, instead of being struck by a felt hammer, are plucked with the fingers. Other string instruments, which are played much like the harp, are the guitar, the mandolin, the banjo, and the zither. The violin, another important

member of the group, is set in vibration by drawing a horsehair bow across the strings, although occasional harplike effects are obtained by plucking. Closely related to the violin are the viola, the 'cello, and the double bass, which are enlarged forms of the violin, producing deeper sounds because of their size and structure.

The next important group is that of wind instruments. The flute, probably the oldest of all musical instruments, is typical. It is merely a closed tube in which the air is set in vibration by blowing into it through a mouthpiece, or through a hole in the side. The piccolo is a smaller form of the flute with a shriller sound. By the use of longer tubes with the mouthpiece, there were originated the instruments known as the horn and trumpet type. The longer the tube, the deeper the tone. It is because of the length of the tube that most instruments of this kind are curved into a more or less circular form. In one type, the trombone, the tube is made in two parts, one fitting into the other so that it may be drawn in or out, thus making the outside one shorter or longer. The familiar cornet and the great bass tuba are likewise important members of the group and are known to musicians as the "brasses," after the material of which they are made.

There is another group of wind instruments known as the "reeds," because reeds are used in their mouthpieces. These reeds are set in rapid vibration by the breath, which in turn starts the air vibrating in the tube, thus producing the sound. Among such instruments are the oboe, the Engish horn, the bassoon, the clarinet, and the saxophone.

A pipe organ is nothing more than a series of improved wind instruments. The air is fed by means of a bellows instead of a player's breath, and many pipes or freely vibrating reeds are brought under the player's control by means of one or more keyboards.

There are two kinds of percussion instruments: drums and bells. Either will serve to exemplify the rhythmic aspects of music. The big bass drum and the smaller drum are used to mark the time and to produce rumbling effects. They produce indefinite sounds of no fixed pitch. The kettledrum, however, may be tuned to a definite pitch and is used in important orchestras. In the bell group are included the devices known as the triangle, the xylophone, the celesta, and the cymbals.

In addition to these important musical instruments there are many minor ones, among them being the accordion, whose sound is produced by forcing air through metallic reeds; the bagpipe, in which the player forces air through three or more pipes by pressure of his arm on a leather windbag; the Jew's-harp, a small, lyre-shaped instrument, which, placed between the teeth, emits tones from a bent metal tongue struck by the fingers; the harmonica, or mouth organ, in which the notes are produced by the vibration of free metal reeds; and the ocarina, a little instrument which has an ovoid shape, with a mouthpiece and finger holes, for the production of whistle-like tones.

Within very few years the motion picture has accomplished more than any other single factor in helping the cause of good music. For example, recent synchronizations have interpolated in their scores movements from classic and contemporary symphonies, as well as fine operas. The result is that motion picture audiences everywhere have cultivated subconsciously a taste for good music. Huge orchestras of symphonic proportions are nothing new to motion picture audiences. The orchestras in the metropolitan houses boast from eighty to one hundred musicians. The compositions they play appear on the programmes of the country's greatest symphony orchestras. In the beginning the motion picture theatre standard did not ven-

ture beyond *Poet and Peasant* and the overture to *William Tell.* To-day the inclusion of selections from the works of Brahms, Tschaikowsky, Liszt, and Haydn is a common practice. Slowly but surely millions of persons have been trained to appreciate good melody and harmony. The motion picture has thus exerted a greater influence upon the musical development of this country than any other institution.

On the other hand, the so-called "jazz" music still has a wider appeal than any other type that we have in this country. The beginning of music itself may be traced to the time-beating of the primitive dance, and the rhythm of ragtime perhaps strikes a deep note in something primitive in our natures. Both ragtime and jazz are of interest, not only because of this fundamental appeal, but because they originated in a typical American source. They have sprung out of the life of our own people and are enjoyed and received like no other. Eventually we may find our ragtime and jazz evolving into a type of American music that will be representative of American life and that will be appreciated and understood by all races of people.

From the beginning, at any rate, music has been a vital factor in the development of the motion picture. In its synchronization with the cinema, difficulties of a technical kind have gradually been overcome until now scores are being made that compare with music played by the finest orchestras. The whole purpose of music with pictures was originally to satisfy the ear so that the eye could give undivided attention to the screen. Upon this fundamental theory great strides were made in blending the emotional force of melody with the appropriate action of the film. Eventually, as the piano and the primitive organ disappeared, fine symphony orchestras have taken their place. Now the score must be chosen with the great-

est care and must be in fullest harmony with the dramatic action. Appropriate accompaniment can do much to enhance the entertainment value of any motion picture. When properly conceived and directed it creates atmosphere for a story and stirs the emotions. However, motion picture scores are merely backgrounds for the picture and should be considered simply as accompaniments. They should not for a moment distract attention from the dramatic value of the scenes. They should never dominate. If a score is arranged in proper harmony with the picture, it will unobtrusively sway the mood of the audiences and put them in a frame of mind to sympathize with the situations enacted. Not only does music help the spectator to concentrate, but it adds emotional value that makes implausible situations momentarily appear convincing. The matter deserves studious care, for what has been accomplished so far is but a suggestion of what may be expected.

The actual preparation of scores makes necessary a wide knowledge of all that is best in music, together with the full appreciation of dramatic musical value. Such work should be assigned only to musicians who have a sympathetic appreciation of the motion picture. The experience and progress that have so far been gained in the synchronization of music with motion pictures has been a splendid background for further progress made possible by the development of sound recording. Music in its very best mood, interpreted by the very best artists, will be sent wherever motion pictures are shown. Although in the past only theatres of large capacity in the most important communities could afford the highest type of musical synchronization, the best now becomes available wherever a theatre is equipped with sound reproduction. Virtually every motion picture of any importance may now be exhibited to a musical accompaniment of the highest

character. The advantage of having a master musician arrange the score for each motion picture is that it insures uniform and practically perfect interpretation wherever that picture is shown.

In order that every mood in the motion picture may be adequately expressed, the preparation of such scores entails research and many weeks of study. The problem of budgeting can be solved only by synchronization, so that a central agency produces for all with full equipment. Situations that call for an Oriental locale carry with them their own musical atmosphere. The soul-stirring anguish of the heroine is interpreted musically; the joyous cries of the populace are enhanced by an appropriate description from the instruments. Orchestras consisting of talented musicians may be employed under expert direction to interpret any effect or scene; and after the record has once been made, on either film or disk, it may be duplicated and reproduced anywhere, any time. The sound device's greatest value to screen art is the fact that the music that accompanies the picture is under the control of the producers of the picture. Dramatic situations that perhaps may be enhanced by singing choruses, heretofore available only in the highest type of motion picture theatres, now may be reproduced on any sound screen. Because of the facilities that are now possible in disseminating the masterpieces of music, the entire standard of appreciation will be raised.

The public, even in the largest theatres in the biggest cities, is entirely satisfied to accept the musical accompaniment that is produced through sound synchronization as a substitute for orchestras. Performers who are replaced because of the introduction of sound devices create a sympathetic and trying problem but one which is not new. Since the time of the earliest mechanical developments progress has ever had to face a similar situation.

Although it is true that mechanical inventiveness in the beginning results in hardship to those who are affected, the outcome in the long run is for the general betterment. When employment of instrumentalists in theatres is curtailed because of the new condition, those who are left without posts seek new avenues for their talents and adapt themselves to the new condition. Approximately one sixth of the musicians in this country have applied their talents to the theatre. These include theatres of every description, and, of course, musicians are not disturbed in what is known as de luxe presentation theatres, vaudeville, or legitimate theatres showing musical comedies or operettas. There are greater opportunities for capable musicians than ever before because of the improvement essential in radio broadcasting. Already music for sound has been of great benefit to talented musicians. They have located themselves in the production centres, where musical scores are made; and it is a matter of record that they receive large salaries and are employed steadily.

The reproduction of music to accompany a picture may be effected either at the time that the picture is being taken or afterward. Both methods are feasible, and each has its advantages. The method by which music is recorded after the final form of a picture seems at present to be preferable. The essential in this connection is simply that the highest quality of reproduction be obtained, for the primary purpose is to provide better music in locations where it is not already available.

It has been found feasible to transmit music and voice currents over distances up to two hundred miles by means of telephone lines, and to record with satisfactory results. The recording and reproduction of stage sound effects has likewise proved practical. The degree of fidelity can now be said to be quite satisfactory, with the temporary exception that reproduction of explosive sounds has not yet

reached the full stage of development that is reasonably expected to take place eventually.

The Victor Talking Machine Company, Columbia Phonograph Co., and the Brunswick Company furnish a cue service for motion picture theatres, which may be used in connection with nonsynchronous equipment. A special record library is furnished by these organizations, and each motion picture is cued so that musical accompaniment may be available to theatres equipped with nonsynchronous devices.

In the production of the singing motion pictures, which may be compared with musical comedies of the legitimate stage, sound has brought to the cinema a type of entertainment that is brand new. The motion picture musical comedy, however, carries with it a deeper note of reality and sincerity than is possible on the legitimate stage. Such productions—Metro-Goldwyn-Mayer's *The Broadway Melody*, the Fox production *Hearts in Dixie*, Paramount Famous Lasky's *Close Harmony*, Warner Brothers' *On With the Show* and *The Desert Song*, and Paramount's *Glorifying the American Girl*—are of different types; yet all certainly point the way to a new convention of screen entertainment.

The influence of the song motion picture, I am convinced, will be felt throughout the industry. Herein are combined drama, comedy, and melody; and it may well be prophesied that sound will have its highest expression in the production of singing motion pictures. This anticipation has already brought about changes and additions in the personnel of the principal motion picture studios. The tremendous appeal that such productions have for the public is clearly indicated by the incredible success of a personality such as Al Jolson's. Hence it is expected that many productions will be presented in which vocalizing plays a very important part. The melody motion picture

likewise gives variety to dialogue, and songs are introduced with ease. Regardless of how well done an all-dialogue picture may be, the introduction of singing at appropriate moments permits a happy and entertaining relief. In the very best dialogue pictures that have songs the high spots that are remembered are the song numbers themselves. In speaking of *The Singing Fool*, for example, one immediately thinks of the hit "Sonny Boy," and the same comment is applicable to similar sound dialogue pictures. Romantic scenes are made more alluring thereby, and good melody in its own right is always pleasing. Finally, operas and musical comedies that have achieved success on the legitimate stage have been produced on the screen with much more telling effect than when originally exhibited on the platform.

In the beginning musical sound pictures were patterned somewhat after musical comedies of the legitimate stage. Why limit the sound motion picture to a proscenium? It is not unlikely that ensembles will be introduced with singing and dancing choruses of more than five hundred persons. As the art of recording is advanced we can well imagine the rousing harmony made possible by such a giant chorus. Here truly is a development in the making, not possible in even the finest opera. We may well expect too that the efforts of our best composers will be devoted to the writing of music for the new medium. A device that makes possible a world-wide audience is worthy of the best efforts of our most talented composers. I do not mean to imply that the sound motion picture will compete with the opera. Music, if the motion picture is to retain its mass appeal, and if it is to be commercially successful, must be based on melody and harmony of the simplest form.

Dramatic dialogue, too, can be made very effective against a background of soft, appropriate music, for it is

well known that stage appeal may be aided by such accompaniment. This is reminiscent of the method used in days gone by on the legitimate stage, and more recently with equal effectiveness in dramatic readings on the radio. Such music must be introduced in a volume that will not drown out any of the spoken words, and if properly handled will help to stimulate the imagination of the audience.

An important by-product of the dialogue picture has been the introduction of the so-called theme songs. The theme song idea was used previously in the presentation of silent motion pictures. We recall, for instance, the very successful introduction of the song *Mickey* some years back, which was featured in a motion picture in which Mabel Normand appeared. During the current year of 1929 the industry has generally recognized the importance of the theme song, as a source both of profit and of exploitation, and song writers such as Irving Berlin, DeSylva, Brown and Henderson, Jack Yellen, and others of equal importance have contributed their talents to the writing of such airs. Some of the most successful popular songs of the year have been theme songs introduced in connection with motion pictures: namely, "I Dream of You, Jeanine," from Colleen Moore's production *Lilac Time*, "Sally of My Dreams," from the Fox production *Mother Knows Best;* "Sonny Boy," from *The Singing Fool;* "Angela Mia," from *Street Angel*, Frank Borzage's production for Fox Film Corporation; and Metro-Goldwyn-Mayer's *The Broadway Melody*, with the theme song of the same name, which also introduced the very popular "Wedding of the Painted Doll." These airs have not only been considered among the best sellers, but have been of immeasurable value in exploiting the motion pictures which called them into existence.

The reader may therefore see how thoroughly, and in

how many ways, the introduction of sound has already altered and augmented the part played by music in the film auditorium. The change has indeed been second only to that of the introduction of speech. It may be even more deep seated. We can, by following the lines of current developments, see clearly whither they are tending and what goals they are likely to reach. What we cannot foresee is the nature of some novelty still unpredicted, or for that matter perhaps now unpredictable; for in the creation of a definite individual medium for sound pictures we may be sure that music, somehow, will be an ingredient of influence. So strong is this belief that producers are neglecting no opportunity to examine, not only existing facilities, but possibilities of creation, or at least of combination. The very incertitude as to what the outcome will be of course contributes vastly to the romance of the situation. And since our calling has never been able to resist pursuing that sparkling phantom, the future of music in sound is fraught with the most exciting hopes and gropings and expectations!

CHAPTER XIII

THE SHORT SUBJECT

The introduction of sound in connection with motion pictures has, among other things, given a new and greater importance to that unit on the programme known as the short subject. Because of sound it receives a new lease of life. Whereas in the past the short subject was limited to a news weekly, a comedy, or a scenic or novelty film, sound has made it possible to bring to the motion picture theatre features from every branch of the traditional theatre and the concert and operatic stages. These offer a rich source of talent not possible when the screen was silent.

In fact, it was through the short subject that sound made its bow to the public. The entertainment that was presented with synchronized film in the very early experiments by Edison with his Kinetophone, as well as other devices of that early period, consisted of short subjects. In the summer of 1926, the first exhibition to the public through modernized sound synchronization equipment was a short subject in which appeared Eddie Cantor, the stage comedian, the recording having been made by the DeForest Phonofilm method. In December of the same year the same company produced a one-act melodrama entitled *Retribution*, which played about thirty minutes and is probably the first entirely talking short subject ever made. Various others were made by the Bell Laboratories and the General Electric Company in the final stages of their preparatory work in the development

of the devices, but very few of them were given public demonstration.

The name "Vitaphone," to give another instance, was introduced to the public through the disk recording method of the Western Electric System in August, 1926, when Warner Brothers gave their first demonstration, which, again, included a programme of short subjects, described in an earlier chapter. After this early effort Warner Brothers produced many like it, in which sound effects, singing, and dialogue were used, and which were accepted by the public with much interest.

In 1927, through the Fox-Case Movietone, which name identified the photographic recording-producing system now used by Western Electric, the Fox Film Corporation presented a series of short sound subjects featuring Raquel Meller, the famous Spanish artiste.

Already the talking short subject has attracted such well-known concert performers as John McCormack, Anna Case, Giovanni Martinelli, Mischa Elman, Harold Bauer, Ernestine Schumann-Heink, Mary Lewis, Beniamino Gigli, Albert Spaulding, Isa Kramer, John Charles Thomas, and Marion Talley. Artists such as Fritz Kreisler, who are now limited to comparatively small audiences, may eventually be induced to make recordings of their art which will be heard simultaneously in cities all over the world. Thus it can readily be seen that many of the prominent artists of the Metropolitan Opera Company and the Chicago Opera Company, as well as the concert stage, have already been made available for motion picture audiences everywhere.

Stars of the legitimate and vaudeville stage who have appeared in short sound motion pictures include Elsie Janis, Chic Sale, Eddie Cantor, Ben Bernie, Beatrice Lillie, Joe Cook, Clark and McCullough, Will Mahoney, Van and Schenck, Vincent Lopez, Willie and Eugene

Howard, George Jessel, Charles Hackett, Leo Carillo, Florence Moore, Blossom Seeley, Lynn Cowan, Weber and Fields, Sally Fields, Richard Carle, Daphne Pollard, the Brock Sisters, Al Herman, Robert Benchley, and many others.

Radio, too, has contributed such performers as the Happiness Boys and Jack Smith; and sound short subjects have been made with motion picture personalities such as Edward Everett Horton, Mitchell Lewis, Hobart Bosworth, Bessie Love, May McAvoy, Johnny Arthur, Lois Wilson, Polly Moran, and Henry B. Walthall.

Whether motion picture audiences will be entirely satisfied to accept vaudeville acts for the screen is a question for debate, but for the present it does seem that more varied entertainment is made available in theatres that heretofore were limited to the silent shorts. It is conceded that with sound they will help to enhance and diversify the programme, and it may be reasonably expected that greater effort will continue to be made to recruit artists and players who will have box office value. Even if this should not be the case, the short subject in sound has a greater entertainment value than the silent short subject.

In the larger cities, the first run theatres have for years embellished their programmes with stage entertainment consisting of either prologues or presentations in which actual performers appeared. The cost of these has made them prohibitive for most motion picture houses. Because of their expense they necessarily can be introduced only in theatres of large seating capacity in large cities, and they have thus become a stable and important part of the so-called de luxe motion picture programme. It has been argued that because of the sound short subject, so-called de luxe theatres will eventually eliminate the stage attractions which embellish their programmes. This is not likely, however, because the managements of such theatres

feel that they must offer an entertainment different from that which is shown subsequently by smaller theatres, who charge a lower price for admission.

Although sound talking pictures are and will be available to motion picture theatres regardless of size and admission price scale, the de luxe theatre, because of the stage number, is enabled to offer entertainment that in a measure is exclusive and different from that subsequently shown elsewhere in the same city. The only exception to this is found in such cities as New York and Chicago, where subsequent-run theatres are of almost the same character as the first run. De luxe houses are able to keep stage entertainment as an exclusive feature because of the physical limitation of the smaller subsequent theatres, and because of the fact that that type of theatre cannot afford the expense involved.

It is therefore more likely that de luxe motion picture theatres will continue to show stage entertainment and will continue to improve it in order to maintain an exclusive feature. At the same time, the de luxe theatre programme will include the very best of the sound short subjects, just as it has in the past. Long run theatres that are located in many of the large cities and that have been devoted to the showing of the very finest of photoplay attractions without stage entertainment of any kind will also continue the practice, and the sound short subject will make their programmes more attractive, in consequence.

In the beginning sound short subjects were made with whatever talent was available, a practice which perhaps resulted in the slowing up of their development. Most of the offerings did nothing more than reproduce the act or routine of mediocre performers. Motion picture audiences, having become accustomed to a high type of screen entertainment, soon looked upon such subjects with indifference, even though they manifested a strong interest in

the beginning because of the novelty of seeing pictures that talk. Some producers, in their anxiety to introduce sound with their product, added sound effects to pictures that had already been completed. Their attempt at reproducing every sound coincident with the action has proved decidedly unsatisfactory.

The sound short subject will have its final test only when the subject is planned as such from its very inception and when talent of the highest character is used in the production. With such incentive and equipment we shall see the development of a new technique in the production of short units for the motion picture programme. Producers who have recognized the possibilities have created novelties that have met with a high degree of public favour. The Fox Film Corporation was the first to recognize the possibilities of the short subject produced with regard to motion picture technique. The first of this type was a dramatic interpretation of several songs by Raquel Meller, recognized Spanish artiste. It was produced through the medium of the Fox Movietone and was first shown at the Carthay Circle Theatre, Los Angeles, on June 8, 1928. It was well received by the public, the industry, and the critics. The first talking comedy that followed screen technique was *The Family Picnic*, produced by the Fox Film Corporation and directed by Harry Dels. Another important production was *Marching On*, featuring Charles "Chic" Sale. This was based on a vaudeville act in which Mr. Sale had appeared. As sound motion picture entertainment it was capably handled for the screen under the direction of Marcel Silver.

A new type of comedy, combining dialogue and singing with action and dancing, thus became possible. One of the first short musical comedies was *The Belle of Samoa*, produced by the Fox Film Corporation with Lois Moran, Clark and McCullough, and a singing and dancing chorus.

These early products also included comedies such as *The Treasurer's Report*, in which Robert Benchley appeared, and others featuring Clark and McCullough. In the production of comedies with sound, producers are getting away from slapstick. Many of their creations are sketches, or one-act playlets, of a type that occasionally has been seen in vaudeville. With the advantages that are acquired through the medium of the screen, such comedies, when well produced, are decidedly entertaining to motion picture audiences.

To Metro-Goldwyn-Mayer goes the credit for producing the first sound picture with natural colour. The title was *Gus Edwards' Color-Tone Revue*, and the film was first shown at the Carthay Circle Theatre, Los Angeles. The sound was recorded by means of Movietone, and the colour was photographed by the Technicolor method. The successful standard attained gave indication of the possibilities in the use of colour photography combined with sound; so that great progress may be expected in this connection, too. With the wider use of colour photography the entertaining value of such short subjects will be enhanced, and performers and artists will appear with practically total realism, as they do in the flesh.

In introducing its first talking photoplay *Interference*, the Paramount Famous Lasky Corporation produced a short subject with Eddie Cantor, in which the star spoke a monologue in comedy vein, referring to the picture *Interference*. The result was a pleasing unit of the programme and indicated future possibilities of the blending of a short subject with the feature.

The Christie Film Company sounded a new note indicating the possibilities of sound with comedy production in their first offerings *When Cæsar Ran a Newspaper* and *The Melancholy Dame*. They have since produced a number of these, the first of which was *A Bird in the Hand*, featur-

ing Miss Lois Wilson, and *Post Mortems*, with Raymond Griffith.

The first sound comedy released by Educational Film Exchanges was *The Eligible Mr. Banks*, with Edward Everett Horton, which was an all-dialogue comedy with sound effects. This was the first of a series along the lines of a type which was produced some years ago by Mr. and Mrs. Sidney Drew as silent motion pictures and which met with popular success.

Hal Roach and Mack Sennett, veteran comedy producers of silent motion pictures, have added sound to virtually all of their efforts, and at this time practically every organization making comedies is introducing sound effects, or musical synchronization, or dialogue. Of particular advantage to comedy producers is the opportunity that is offered for appropriate musical accompaniments. It is a well-known fact that music, when intelligently applied, may do much to enhance the enjoyment of comedy subjects. Farce, which has heretofore been difficult to convey convincingly in the silent motion picture, becomes practicable with the use of dialogue. Through sound, likewise, it now becomes possible to screen miniature musical comedies and to bring an entirely new note of entertainment to film theatres.

On December 31, 1927, through the Fox Movietone, was shown the first regular issue of the sound news, which contained talking subjects and made possible the reproduction of any event through sound as well as photography. The news reel, long taken for granted, has always been an auxiliary to any motion picture programme. With sound, its value is increased twofold. First, it speaks with the clear ring of the human voice. Secondly, the voices of prominent persons throughout the world can now be perpetuated for all time.

The development of the sound news reel must be at-

tributed entirely to the Fox Movietone News, through whose services motion picture theatregoers have not only seen the world's news but actually heard the sound as well. Among the famous men who have been recorded on the Fox Movietone are Calvin Coolidge, Colonel Lindbergh, the King of Spain, the Prince of Wales, Benito Mussolini, George Bernard Shaw, Lloyd George, Ambassadors Herrick, Fletcher, and Hammond, Aristide Briand, former Governor Smith, and President Hoover. Plate VII shows Fox Movietone News reproductions. Furthermore, what with the world-wide organization of the Fox Movietone News, it has become a weekly feature in practically every important theatre throughout the country. Its popularity increased to such an extent that two issues weekly were released; these were afterward increased to three weekly issues. Now announcement comes from William Fox that further increases will be made, until eventually one complete release will be offered every day. This is an accomplishment that even the silent news weekly has not been able to boast. In anticipating a goal of a news reel a day the Fox organization bases its prophecy on the fact that the public demands its news fresher than the biweekly issues can bring it. Accustomed to receiving news from the daily press within a few hours after it has happened, the public will naturally wish the same service from any other news agency.

An interesting issue was shown recently by the Fox Movietone News, when two Presidents and one ex-President were presented on the same programme—William H. Taft, Calvin Coolidge, and Herbert Hoover. It can readily be seen what an important part the present-day subjects will play in recording the visual and auditory history of the world. The short subject becomes an archive which will prove of great value to the future. It becomes a living encyclopedia of the important personalities of the age we

live in. Hence, it is only to be expected that other film organizations will eventually produce news in sound. The Pathé News already are offering such a service, and other organizations, such as Metro-Goldwyn-Mayer and Paramount Famous Lasky, will soon offer sound as part of their regular news reel service.

In the early development of a silent motion picture, the short subject comedy was a factor in developing talent for the feature-length photoplay. It is interesting to note, by the way, that several of the screen stars served their apprenticeship in the old days as players in short subjects. They were thus fitted in a measure for the more important work they did in feature length motion pictures, and several of them attained stardom. When it is considered that the number of real motion picture stars, even in the fullest development of the silent photodrama, was limited to a comparatively small number, the importance of this early apprenticeship can readily be recognized. Among the most prominent of those who had their beginning in the motion picture industry via the short subject route are Mary Pickford, Charles Chaplin, Harold Lloyd, Gloria Swanson, Norma Talmadge, and Lillian Gish. In addition to these there are many featured players who received their fundamental experience while appearing in short subjects. It is therefore likely that the short subject in sound will play an important part in the development of talent for the feature sound motion picture, just as sound itself was introduced by that door.

Similarly, since many experiments that might prove to be too expensive to undertake in connection with the production of a feature motion picture can well be experimented on in short subjects, practically every important producer may be expected to encourage and foster short subject productions.

Again, sound has made possible an enhanced value in

PLATE. VII. FOX MOVIETONE NEWS REPRODUCTION OF THE KING OF SPAIN AND GEORGE BERNARD SHAW

photographing natural scenery, so that now the screening of Niagara Falls has far greater value. The recording of nature's voice, in the singing of birds, the roar of the breakers, the patter of rain, all help to bring a greater naturalness to the subject photographed.

Already we have heard important governmental officials of the greatest nations deliver public messages before important bodies, as well as messages of good will directly to the people of foreign countries, by use of the sound short subject. The world is made intimate with great statesmen, and important personalities are in this way brought to the most remote hamlet in the world. The importance can readily be appreciated and should result in a greater appreciation and an increased interest in the motion picture by people everywhere.

Of great significance to the sound motion picture feature is the development of the so-called sound trailer which advertises coming productions. Such trailers have been of immeasurable value in announcing forthcoming attractions to theatre audiences. They have been of great interest particularly when important players or stars make the announcement of the picture in which they will appear. When carefully planned and prepared they are of splendid entertainment value and carry a convincing advertising message.

It may be expected that scientific subjects will be recorded with greater fidelity than has been possible for the silent motion picture. The science of surgery will benefit materially in that operations will be recorded as performed, accompanied by lectures by the best surgeons, and in that such recordings will be available in the most remote hamlet. The sound and photographic record of the explorer will not only be of interest to the public, but will have added scientific value as first-hand source material in times to come.

Even during the reign of the silent screen short subjects were fascinating. They drew the public, for they were not only interesting in themselves, but added attractively to the value of goods received for the price of admission. In the latter regard they were a boon to operators, who featured them on programmes and in advertising as proved drawing cards. To producers they were a fertile field of variety and a means of increasing the output of manufacture. And they were often laboratories for experiment that paid their way as entertainment.

Now, in addition to repeating their history in certain respects, they are the vehicles of further enrichment. They bring us the musical show, the concert, the opera. Who knows what they will bring us next?—these little brothers of the film that so often grow up to be very big indeed!

To conclude the section on contributive features, I wish to point out the fact that if I have mentioned only three it is because these have either been changed greatly by the new phenomenon or have brought changes into the theatre. The other auxiliaries are still in use—colour effects and lighting, ornament in interiors, expert advice. Of the last I have said much in a new connection in the chapters on the theatre and the studio. As for the others, I have told all I care to say in a previous work, where the information is ready for those who are interested.

The public is desirous only of a good show in a good theatre—and rightly. We on the inside know how complex is the organization that ministers to that simple demand. We know what must go on, for example, in council and counting rooms before the crowd lines up at the ticket office. In connection with our latest venture we have learned that fact all over again. Ours is a mighty tree of many branches; a growing tree that shall put forth yet

more and more. With each development the ramification becomes vaster.

What will the future be? The question, of a new thing like sound, seems part of its very life. Well, then, let us turn our faces that way; and now that the record of experience is made let us in the last section gaze into the crystal called "To-morrow."

Part Five

THE OUTLOOK

CHAPTER XIV

SOCIAL AND COMMERCIAL USE OF SOUND

ALTHOUGH our theme has been narrowed, for obvious reasons, to sound as entertainment in a theatre I am not unmindful of its interest and significance elsewhere. As a matter of fact, the employment of machinery to reproduce auditory stimuli had its inception outside our industry in the phonograph and the radio. It should therefore not be surprising that the movement as a whole is bigger than the theatre and is beginning to have applications in other realms of human activity. Indeed, the scope of possibility is so wide and varied as to make prophecy well-nigh irresistible. We have seen the wildest daydreams of yesterday come true in our generation; and in view of the facts it has become advisable to think twice before dismissing anything as preposterous! Accordingly, when one looks ahead a few years to the progress of an innovation already a reality, speculation ceases to be mere speculation and takes on some of the character of calculation. If the history of man comes some day to be written in terms of material standards our age will be accorded a high place. If, on the other hand, values are measured by a different standard—if human achievement is tested ultimately according to the growth of the spirit—then we are fortunate again; for our time must certainly be known as the one in which performance has turned hope to victory and doubt to optimism. We have dared to do; now we dare to dream; and in that eternal truthfulness we have found health and aspiration.

I therefore venture to predict that, within limits only of utility, the reproduction of sound by machine will be employed wherever sound itself is now employed. Perhaps the determining factor in each case will be the extent of the social group interested or involved, since the function of machinery is generally not so much to create as to augment and multiply. The truth of this was long ago exemplified in the manufacturing trades. Now no less is it borne out in the introduction of sound in the theatre—a service to millions. Similarly, any human occupation that appeals to vast numbers and that involves in any way the use of the sense of hearing, at once becomes a prospective field for the new movement. I do not write this statement without realization that many good folk may smile at it. Jules Verne was ridiculed for coolly writing about the submarine and the airship in an age to which such things were fairy tales. H. G. Wells was regarded indulgently by most of the public when, in his *When the Sleeper Wakes*, he described in detail the fantasies we now know as the radio and the talking motion picture! The scoffers of today may be proved wrong in the sequel. I only hope that they are not the same ones who ridicule the incredulity of their fathers and their grandfathers.

As I see it the use of sound apparatus will have four broad applications in fields not essentially connected with entertainment. In none of these expectations, furthermore, can anyone proclaim himself an out-and-out prophet, for the simple reason that in each of them a recognizable beginning has already been made. In addition, signs point to the acceptance of such beginnings and a decided tendency toward development, or at least further trial. The four domains I have in mind are: first, science; second, education; third, commerce; and last—for lack of a more specific term that would be equally inclusive—social life.

Nor have I placed science first either by chance or out of

deference to a contemporary fetish. The fact is that scientists have gone so far in adopting the device that, as I say, one need not be a prophet to recount its probable line of development in the future. The reader may be astonished to learn, for example, that in Europe there are already two theatres devoted exclusively to the showing of scientific pictures: one in Vienna, operated under the direction of the Astrologic Institution, and the other in Berlin. Furthermore, scientific and geographic expeditions are now enabled to carry sound motion picture apparatus with delicate microphones and to record their findings with increased richness. The explorer may photograph the sounds as well as the image of natives and habitants of newly discovered regions. Museums are in the same way able to record the sound of living creatures.

America has already made a remarkable contribution to medicine and surgery through motion pictures. Particularly noteworthy is a series which was produced by the Eastman Kodak Company for the American College of Surgeons. These record intricate and difficult operations, performed by the greatest practitioners, and make valuable data available to medical students throughout the world. Such films will be greatly improved when accompanied by explanatory lectures. The latest discoveries in the medical profession may in this way become immediately available everywhere, just as, undoubtedly, they will establish a permanent record for future study. Only recently a talking motion picture in natural colours was used to record an operation performed by a surgeon at the New York Post Graduate Medical School and Hospital, who delivered his lecture at the same time that he performed the operation. This film method of teaching has already been said to be more effective in many instances than the clinic and operating room demonstrations. Thus far the films developed by the Post Graduate Medical School have been

used principally to explain the technique of skin grafting, reconstructive surgery, and the correction of nasal disfigurements; but there is no reason to believe them limited to any field. The ability to produce the actual colours on the screen, together with the accompanying lecture, gives the medical student an opportunity for closer study than that afforded him in the clinic, especially since the subject, by means of the motion picture, is magnified many times.

This brings us, by natural transition, to the more general matter of education. Visual instruction will receive a great impetus from the medium of sound motion pictures. The efforts of eminent teachers and lecturers will be brought to the most remote schoolroom, and series of sound films on every conceivable subject will become available to educational institutions. This will mean that an exchange of lecturers and teachers will ultimately become a simple matter. It will be necessary only to syndicate the demonstrations and lectures of a few master teachers for widespread audition. In remote places pupils may be instructed more interestingly and more quickly than at present, and will be privileged to listen to the lectures of great teachers and national leaders and to receive the inspiration of their speaking personalities. Much more important than that, local teachers will be liberated from the slavery of cramming facts and be free to exercise a closer supervisory contact with pupils. The motion picture screen teacher will by example raise the standard of teaching, for it is to be expected that only the very best teachers will be used for such a purpose. The result will be a higher quality of instruction.

In this light, moreover, the university home course takes on new possibilities. Sound motion pictures are more than likely to be an important factor in this progressive educational movement, for they offer the opportunity to present courses by and under the guidance of qualified

educators to those who cannot undertake classroom work. Courses can be specially prepared to meet the requirements of study at home or of groups in localities remote from centres of learning. The subjects will be prepared by the teaching staffs of prominent universities. This will result not only in the attainment of greater efficiency in business and in the professions, but in a fuller social life and in the propagation of a more intelligent point of view. The sound motion picture will prove of special value, for instance, in the teaching of languages at home through the use of the home device, which would have the tendency to make such courses more interesting and attractive than lessons conned from books or written lectures. In the specific connection of our own tongue, too, it is believed in some quarters that America's speech will be uniform throughout the land in twenty-five years. This prediction has been made by Prof. John Hom Muyskens of the University of Michigan. The Southern drawl, the nasal twang of the Easterner, the broad "A" of Boston, he declares, will be merged into a common pronunciation; and who can doubt that uniformity in speech will be a stepping-stone to national solidarity?

The value of sound motion pictures for training purposes has actually been recognized by the War Department. Recently, in coöperation with the Fox Film Company, and with Movietone as the medium, there have been filmed and recorded the typical activities of three training groups. The first shows the organization of the medical units. The second is devoted to the exposition of assembly and disassembly of weapons. The third reveals the infantry battalion in action. Finally, the troops are pictured under war conditions, with machine-gun fire, artillery barrage, and operation of scout planes. Between the scenes instructors are shown at a blackboard, demonstrating and discussing the military problem under consideration.

The result of this experiment has been found to be so satisfactory that the course is being made part of the army curriculum. It may therefore be assumed that had sound photography been perfected during the World War it would have been an aid in transmitting messages and signals, as well as in recording important orders and conversations. It would thus have been particularly adaptable in connection with intelligence work.

There is no limit, in other words, to the *applicability* of the device to educational procedure. The *practicability* is of course another matter. Yet the attitude of educators is reflected in the statement of Dr. Gustave N. Straubenmuller, Associate City Superintendent of the New York schools, who has said in effect that, though practical considerations rendered the movement inadvisable at the time, he had no doubt of the ultimate consummation. In other words, the inclusion of sound motion picture instruction in the public institutions is only a matter of time and administrative adjustment.

Now, what of the world of business? For many years the phonograph has actually been put to practical use in commerce, particularly in transcribing dictation. Synchronized with motion pictures, in its latest development it will be put to a far wider use than ever before. To the exploitation of merchandise, for example, the sound motion picture brings new possibilities. Manufacturing companies are confidently expected to use sound pictures increasingly as an aid to salesmen and advertising departments and for organization purposes. Pictures will show all sorts of industrial processes, scientific experiments, and educational demonstrations. Why not? They are a splendid medium for the transmission of ideas and the processes and knowledge to large numbers of persons. The talking pictures will deliver the messages of factory executives to their employees, to their conventions, and to

prospective customers in sales and demonstration rooms. Executives and sales managers will send their messages to their field staffs by means of the device. Sales will be made through demonstrations by talking pictures.

Furthermore, a complete sound and photographic record of conventions, banquets, and important meetings is now made possible. Such proceedings may be recorded for all time, eliminating possibility of error in transcribing or reporting. Sixteen millimeter film could be used, particularly when a record of speech only might be desired and when a minimum of storage space is a consideration. Such film is less than half the width of the standard size; and since five pictures on the small film are equal in length to two pictures on the larger, a 400-foot reel of 16 mm. film is equivalent to a 1,000-foot reel of standard film. Thus the 16 mm. film can be handled at a lower cost, and requires lighter equipment in recording and reproduction. There is already at least one interesting example: recently an important group of bankers were assembled at a dinner where a keynote message was to be delivered by an important personage. Unexpected circumstances made it necessary for the man to be abroad on that date. The day, however, was far from lost. A Movietone was made of his talk and was shown to his astonished and delighted co-workers!

The amplification of sound, as we all know, has for a number of years been put to successful commercial use through the medium of the public address system, which is in many respects a counterpart of the amplification used in the reproduction of sound motion pictures. Public address systems have been employed with a considerable degree of success in banquet rooms, large auditoriums, and public places to convey the addresses of speakers to great audiences so that all present may clearly hear everything said. At the recent inauguration of President Herbert

Hoover units of the public address system were placed at vantage points and brought to the many thousands of persons before the Capitol every word uttered at the ceremony just as clearly as if they had been on the platform itself. This system has also been widely used for the making of announcements at sporting events, for the transmission of music to remote rooms, and for other kindred purposes.

It is likely that the sound device may create talking show windows. The display of merchandise could be accompanied by an intelligent description, which might be recorded either on a sound-on-film record or on disk, reproduced out of sight, and transmitted to the front of the show windows by means of amplifying loudspeakers set behind grilles in the face of the building. At times, soft musical accompaniment could be used as an inducement to attention. Gifted speakers might be engaged to deliver messages of interest, prepared by talented advertising writers. The principle has already been applied in connection with the lobby displays of the Fox-West Coast Theatres, with success.

For a long time advertisers have used motion pictures as an advertising medium. With the addition of sound there will probably be a wider employment of the screen. The future of advertising in this connection, however, is limited because the exhibiting factors in the United States do not look with favour upon the practice of using motion picture screens for advertising purposes. The progressive element feels that the public pays admission to see entertainment and not to have advertisements thrust upon it. In rebuttal, it has been argued that the very best newspapers and magazines use advertising without offending their readers. In such instances, however, it is not necessary for the reader to read the advertising unless he chooses; whereas the patron must watch the screen at all

times or else close his eyes—which may not prove convenient or desirable!

The development of a sound-on-film photographic device to record telephonic messages is another probability. With the increased use of telephone service in the transaction of business, a record of the conversation might be of value for reference. If it is proper that we keep a record of our written correspondence, why should we not also keep a record of our telephonic communications? The close affiliation of the Western Electric, a subsidiary of the American Telephone & Telegraph Company, with the development of sound reproduction, should make the perfection of such a device a comparatively simple undertaking. A kindred procedure, but for the protection of property against depredations of criminals, is actually under consideration. It is believed that sound-reproducing apparatus may be of use in detective work through the recording of evidence procured in shadowing suspects. Such instruments may be planted out of sight and would record conversation through the use of delicate microphones.

Crime prevention or detection may be rated a negative contribution. More positively, too, I feel sure, will the application of sound have its effect upon that phase of life which we call social. The sound machine is going to exert an influence in religion, in current history and politics, in home entertainment, and in reading.

The sound motion picture is likely to become a factor in modern church work. Sermons by prominent and talented preachers may be circulated at will, bringing to all the best available religious doctrines presented under the most favourable auspices. The most learned and eloquent ministers will give inspiring sermons without limitation of audience. The opportunities for the use of the device in the educational work of the church are obvious. Small churches

will be awakened to a new interest through the opportunity of hearing and seeing the really great ministers and religious leaders, a privilege which may have the tendency to replenish many shrinking congregations.

Through talking pictures, again, revolutionary changes will be brought about in the handling of political campaigns. Already we have seen the talking picture used in connection with the last national political campaign, when President Hoover and Governor Smith spoke through this medium to thousands of audiences throughout the country. In such campaigns the participants will speak in screen person to all the voters simultaneously, without the discomfort and physical exhaustion of the past. Incidentally, this means that future generations will not only see but hear the great characters of this period, and of others to come, because here is a new means for recording history. It can be imagined what it might mean to the youth of to-day, for example, were they able to see and hear Lincoln delivering his immortal Gettysburg Address.

Yet the step which will provide the widest scope to all these will be taken when special sound equipment in connection with motion pictures is installed in private homes. A small suitcase apparatus, one of the latest developments of the Bell Laboratories, is a complete sound system. It includes a projector, which uses standard Movietone film. An even simpler and less expensive device has been made available by the introduction of a home projector with a synchronizing unit, in which 16 mm. films are used. The apparatus is known as the DeVry Cinetone, and consists of a phonograph turntable mounted on the same base with a 16 mm. projector. The turntable is geared by shafting direct to the mechanism of the projector, so that the two may be in synchronization. The reproduction of the sound on the phonograph record is electrical, so

that an electrical cord may connect the sound reproducer with a radio loudspeaker. This machine will play any of the electrically reproduced standard phonograph records. It is furthermore so designed as to be used as a motion picture projector, or as an electrical phonograph, or for the reproduction of a synchronized talking motion picture produced by the manufacturers. Regular releases of talking and singing films are issued at frequent intervals. These are in the form of dramas, recitations, and songs. As the voices come from the phonograph record the portraying characters appear on the screen in synchronization.

It will be only a comparatively short time before a combined talking machine-radio-motion picture, together with sound-reproducing equipment, will be procurable in a compact cabinet for home use. Such a combination will probably be offered under the auspices of the Radio Corporation of America. It is this possibility that in all likelihood caused the corporation to acquire control of the Victor Talking Machine Company. Undoubtedly the introduction of such a machine will mark the dawn of a new era in home entertainment.

With the perfection of this machine, moreover, simplified sound cameras will make possible the photographing of sound subjects by the sound-on-film method, will be simple enough to be operated by amateurs, and will bring to amateur motion picture photography a tremendous additional interest. It will then be possible to make sound motion pictures, for example, of children at play. It can be imagined how precious will be such a visual and sound record that may be passed down from generation to generation. The pleasure that one may derive from having intimate sound pictures of important events will also be great indeed. The addition of colour to such home sound motion pictures is entirely practical by use of a colour filter now in actual use.

Finally, "talking books" are a development along scientific entertainment lines that are being offered to the public. A company has recently been formed for the purpose of publishing record versions of books as well as to license book publishers to manufacture and use their records and machines. A specially prepared disk which can run seventy-two minutes is the means of exploitation. The record is sixteen inches in diameter, and a book of 350 pages can be recorded on two sides of the disk. In this manner best sellers may be recorded and made available in circulating libraries and book stores. This innovation may be expected to create a new reading-listening public. Books may be recorded with incidental musical accompaniment, to suit certain passages of the story. Although the innovation was originally intended as a means of furnishing reading matter for blind people it is adaptable for other commercial purposes. Through the use of such a record an entire entertainment can be recorded and afterward sent over a radio sending station. This might be a very valuable means of advertising a particular entertainment, since a whole programme can be made and then broadcast. Such a procedure would take the place of a national hook-up; records could be furnished each station instead of sending it from a master station over leased wires. When one learns that an entire opera may be recorded on ten or twelve records the significance is obvious.

Fifty years from now the average American public library, in addition to offering its shelves of the printed works of Shakespeare, Voltaire, Ibsen, and Shaw, may be equipped with reproducing projectors, and a complete record of the plays of our day may be available, as well as the speaking images of the great personalities.

It is easy to see, then, that the commercial utility of sound is only partly bound up with its fate in the theatre. Of course, some of the phases I have discussed in this

chapter are capable of theatrical presentation. Certain topics of science, exploration, and education may be parts of the programme, just as the news reel now includes matters of current history and of geography. Or else, in a more remote future, there may come into existence specialty theatres, like the German ones I mentioned, for audiences which create such a demand.

However, in the sense in which we use the word theatre to-day, a great deal of future exploitation may lie outside the industry. Schools, libraries, shops, and commercial establishments may very well develop facilities and techniques of their own. In other words, the mechanization of sound is no mere amusement enterprise. In the larger view, it takes on the proportions and reveals the implications of a world, or, at any rate, of a national movement. Since the theatre is the pioneer others will come to us for guidance. Doubtless they will come to our studios for their product, and the basic procedure will thus tend to be universal.

Our interest in all this is therefore twofold. On the one hand there is the pragmatic consideration of markets increased and multiplied. On the other hand there is the reassurance that what we have undertaken can be no mere fad. What interests all people, what ramifies its possibilities wherever we turn, cannot fail to have lasting effect upon the business we are engaged in. The sound motion picture has come to stay because it is at once the voice of the era which has ushered it into being and the most characteristic product of that era.

CHAPTER XV

THE FOREIGN MARKET

In the general upheaval which has shaken the film world at the emergence of sound no single factor has received as much thoughtful consideration as that of export. Indeed, one may well remark that in a measure, as the new movement sweeps the domestic trade, the leaders knit their brows more intently over the riddle of conditions abroad. The problem is not entirely, as I have hinted in an earlier chapter, one of language. That in itself constitutes a snarl of serious complexity; yet, if that were all, it would surely yield to the fingers of time and patience. There are, however, other complications—a whole network of them, as one might readily expect. International questions are ever as stubborn as delicate and have a way of developing subtleties in inverse ratio to their initial simplicity.

Without attempting to minimize the difficulties of the outlook it is nevertheless of some steadying influence to realize the simple fact that, however great the problem, it is no more perplexing than countless others that have succumbed to the vigorous intelligence of American industry. What thought and persistence and tact have done before, and are still doing in many domains of salesmanship, can be done again. The challenge of reconstruction will daunt only those who have drifted with the tide. It will be breath to the nostrils of the fighters, young or old. We of the motion picture world need have no fear of a mere problem. Have we not triumphed over an enigma?

It will take time, of course. In the interim synchronism

is drawing into our coffers a new flood of good American dollars—still acceptable currency! It will probably serve not alone to revive the interest of the vast army of movie fans, but will attract a host of new friends, to a number now incredible. We are offering the public an entertainment no longer of a certain kind but of all kinds. This time our function is not to create one demand but to supply many. Throughout the history of our nation certain forms of diversion have been denied to all save the small fraction of those who live in or visit the metropolitan centres. We have changed all that. We have scattered the benefits of urban pleasures to the farthest crossroad. There we find the same appetites, the same hungers that stir in the cities. We have tapped a craving utterly beyond our present instruments to gratify. This is the new home market; and with the thought of it to ballast us against uneasiness we can turn the mind elsewhere, to face threat or promise squarely and calmly.

From 30 to 40 per cent. of the gross revenue of a motion picture has come from other countries, and the economic structure of the industry has been set up on that basis. To what extent will the innovation interfere with the important revenue that has been obtained in the past from foreign countries? The advent of the talking picture has created a real problem in this regard, since English-speaking pictures are not likely to meet with the same degree of success in non-English-speaking countries as have the silent ones. Until now most foreign countries have shown a preference for those American motion pictures that have sound and orchestral accompaniment without dialogue, for naturally their people, outside the British possessions, do not understand the language.

The silent motion picture offers entertainment within the reach of all the world. It was estimated that in excess of ten million people attended such film performances

each week in 1928. Although the United States possesses about 6 per cent. of the world's land and its people make but 7 per cent. of the world's population, in 1928 we produced about 85 per cent. of these motion pictures. It is doubtful that American producers can continue to hold the market by the continued production of silent pictures, because all the principal foreign producers will eventually manufacture dialogue pictures in the mother tongue. It is only to be expected that the people of a foreign country will favour sound motion pictures in a language that they can understand. American short talking subjects have not been received with favour in other than English-speaking countries. Furthermore, it would appear that no American motion picture in which speech dominates will succeed abroad.

It is thus apparent that the problem of furnishing pictures to the world market, with its multiple tongues, is a serious one for the industry. Sound is likely to give foreign producers their long awaited opportunity to compete with American pictures in their own countries. Although practically every producer here is making a silent version of the dialogue picture for the foreign market it is questionable whether such pictures will continue to enjoy the popularity of the American silent motion picture of the past. It would appear, likewise, to be a makeshift merely to translate English spoken dialogue to written titles for foreign versions. It is possible that enterprising American producers may make different language versions for the more important foreign countries, with special casts recruited for that purpose. It is conceivable that producers may make German, Italian, or Spanish versions with special casts while the sets are in active use at the studios. However, the cost of such a procedure as a general policy is likely to prove prohibitive.

The problem that faces the producer of sound motion

pictures in connection with the world market can be further appreciated when it is considered that there are seventy-two different languages in use in foreign countries throughout the world! The following is a list of such languages prepared by Dr. Theodore Henckels, Chief of the Translation Section of Regional Information of the Bureau of Foreign and Domestic Commerce:

Algeria—French and Arabic.
Arabic—Arabic.
Argentina—Spanish.
Australia—English.
Austria—German.
Belgium—French and Flemish.
Bolivia—Spanish.
Brazil—Portuguese.
British Guiana—English.
British Honduras—English.
British West Indies—English.
Bulgaria—Bulgarian.
Canada—English and French.
Ceylon—Singhalese.
Chile—Spanish.
China—Mandarin.
Columbia—Spanish.
Costa Rica—Spanish.
Cuba—Spanish.
Czecho-Slovakia—Czecho-Slovak.
Denmark—Danish.
Dominican Rep.—Spanish.
Ecuador—Spanish.
Egypt—Arabic and French.
Esthonia—Esthonian.
Finland—Finnish.
France—French.
Germany—German.
Greece—Greek.
Guatemala—Spanish.
Haiti—French.
Honduras—Spanish.
Hungary—Hungarian.
India—Hindustani, Bengali, Gujarati, Tamil, Urdu, and Telugu.
Indo-China—French.
Iraq—Arabic.
Irish Free State—English and Gaelic.
Italy—Italian.
Japan—Japanese.
Latvia—Lettish.
Lithuania—Lithuanian.
Malaya (British)—Malay.
Mexico—Spanish.
Morocco—French, Arabic.
Netherlands—Dutch.
Netherland East Indies — Dutch and Malay.
New Zealand—English.
Newfoundland—English.
Nicaragua—Spanish.
Norway—Norwegian.
Palestine—Arabic, Hebrew.
Panama—Spanish.
Paraguay—Spanish.
Persia—Persian.
Peru—Spanish.
Poland—Polish.
Portugal—Portuguese.
Rumania—Rumanian.

Russia—Russian.
Salvador—Spanish.
Siam—Siamese.
Spain—Spanish.
Sweden—Swedish.
Switzerland—French, German, and Italian.
Syria—Arabic, French.
Tunis—Arabic, French.
Turkey—Turkish.
Union of South Africa—English, Dutch, and Bantu.
United Kingdom—English.
Uruguay—Spanish.
Venezuela—Spanish.
Yugoslavia—Serbian.

It can readily be seen that the former world market may narrow down to English-speaking countries if the dialogue picture continues to make rapid strides at home, unless sound motion pictures are produced in foreign tongues. Eventually the American industry is likely to release fewer domestic pictures abroad, but the pictures that are released abroad will be the cream of our effort. Europeans have expressed the opinion that their continent is used as a dumping ground for some American-made motion pictures, and that if there were a better understanding as to the type of pictures the foreign market requires there would be a kindlier feeling toward the American motion picture producer. This charge would appear, however, to be without foundation, because the European market has been given product of the same character and quality that has been produced here. It would appear that in the future, however, motion pictures for the American market will be limited to a single adaptation—either with dialogue or without sound at all. Only those that appear certain of approval abroad will be made either silent or in a foreign language.

American producers continue to experience great difficulty, moreover, in serving the European market because of the restrictions placed upon American-made pictures by the principal foreign countries, and it may be best for American producers frankly to face and discuss a situation that must eventually be confronted. Quotas and

other forms of legislation in foreign countries have already caused a drop in exports in 1928 as against 1927, according to figures furnished by the Motion Picture Section of the Department of Commerce. Statistics for 1928 show a total of 222,122,586 feet, as against 232,104,833 feet for 1927.

The following table gives the information in detail in relation to the various countries:

COUNTRY OF DESTINATION	1927 LINEAR FEET	1928 LINEAR FEET
Latin America	82,931,241	78,960,444
Europe	69,579,175	69,841,259
Far East	58,827,593	54,335,108
Canada	10,920,724	8,814,462
Africa	3,882,836	3,772,094
Other countries	5,963,314	6,357,672
Total	232,104,883	222,081,039

In ten major markets, American exports dropped from $4,727,756 in 1927 to $4,079,288 in 1928, the totals representing invoice, not royalty, values. Comparisons of the standing of the ten leaders for both years follow:

		1927	
COUNTRY	RANK	LINEAR FEET	VALUE
Australia	1	27,017,656	$687,058.
Argentina	2	23,730,723	599,818.
Brazil	3	15,921,565	420,215.
United Kingdom	4	13,806,498	1,440,036.
Germany	6	10,187,606	350,858.
Canada	5	10,920,724	395,164.
Mexico	7	9,336,083	254,862.
France	8	6,781,717	206,004.
Spain	9	7,896,226	176,939.
Japan	10	7,103,883	196,811.

COUNTRY	RANK	1928 LINEAR FEET	VALUE
Australia	1	25,400,562	$563,350.
Argentina	2	20,161,142	517,199.
Brazil	3	16,464,410	392,239.
United Kingdom	4	12,699,349	1,074,096.
Germany	5	11,219,271	425,433.
Canada	6	8,814,462	337,783.
Mexico	7	8,662,988	235,696.
France	8	8,240,266	202,436.
Spain	9	7,932,747	187,900.
Japan	10	6,227,686	143,156.

As though to supplement this state of affairs the British motion picture industry is beginning to find its way into the world markets. For example, fifteen British films were sold in Germany in 1928 as compared to only two in 1927. British exports to France increased from eight in 1927 to twenty-three in 1928. The Paris Trade Commissioner for the American Film industry issued statistics that showed that, whereas a few years ago England could not get half a dozen films a year into the United States, she was second on the 1928 list of foreign film imports with thirty-seven to her credit. Although British films can exist without a slice of the American market they can never flourish unless they have it. With American representation assured, more money can be spent on production, and the quality can be improved and the scope enlarged. At the present time there are no quota acts or contingents or any other legislative barriers to their entrance into the United States. On the other hand, until 1928 few British pictures found their way to American screens. British producers blamed the hold of the American industry over exhibitors, while American exhibitors blamed the quality of British films. A statement made by Mr. Will Hays in a message sent to a British cinema magazine may be taken

as the American film industry's attitude on the question. He declared:

> I sincerely commend every effort which is being made to bring our two countries closer to each other through the motion picture; and I repeat that there is a whole-hearted welcome in America for films which reflect the centuries of English culture which, we claim, is our heritage.

This spirit has created a greater degree of friendliness between the film industries of the two great English-speaking countries.

Great Britain is now operating under a quota law which guarantees the home market for ten years. A $100,000,000 fund is provided to build a moving picture industry at home. In the field of operation England has approximately thirty-seven hundred motion picture theatres. In addition to this its colonies contribute as follows:

Australia	1216
New Zealand	426
India	309
South Africa	400
Canada	1000

It may be expected that most of these countries will introduce a British quota law similar to that of Great Britain.

The quota law provides that $7\frac{1}{2}$ per cent. of the total footage exhibited in British theatres during 1929 must be British made. In 1930 and 1931 this ratio is increased to 10 per cent.; in 1932, $12\frac{1}{2}$ per cent.; in 1933, 15 per cent. in 1934 and 1935, $17\frac{1}{2}$ per cent.; and from 1936 to 1938 inclusive, 20 per cent. Only time will determine whether the British film industry can produce a commodity which will justify these conditions.

Cinema control legislation is likewise in effect in France. Although the original French terms were very severe, a

modification was made through the efforts of Will H. Hays of the Motion Picture Producers & Distributors of America by arrangement with the French government. This permitted 60 per cent. of American importations to be admitted free into France. For any above this level American producers are required to distribute a certain number of French films in the United States in order to obtain the necessary licenses. As an alternative they are required to purchase licenses from the French producers, who receive seven licenses from the Cinema Control Commission for each film produced in France and deemed worthy by the Commission. It is felt, however, that such regulations have not furthered French motion picture interests outside of France, and it is likely that more rigorous regulations will be adopted. Recently a large number of exhibitors petitioned the French government in protest against drastic regulations that would curtail the showing of American motion pictures in France. This protest was aroused by the fact that the Ministry of Public Instruction was preparing a series of new regulations which would impose a three-to-one quota upon American producers. Under such a plan American films would be reduced approximately 50 per cent. The rest presumably would be imported from Germany and Britain, with whom French producers have formed a European bloc.

Germany was the first country to regulate imported American-made motion pictures. Restriction was rendered effective by making it necessary to produce a motion picture on German soil for each American motion picture admitted. Modifications, however, were arranged later to permit the importation of an American-made motion picture for each German picture distributed in America. It may be said, generally, that in countries where American films have been restricted theatre attendance has in many instances been decreased. This result is an indication that

the people of such countries do not look with favour upon the restrictions imposed upon American motion pictures.

Not all foreign countries have been successful in exploiting the pictures produced by their own nations. In Spain, during 1926, sixty motion pictures were produced; yet in 1927 but twenty-five were made; and in 1928 the number was reduced to nineteen. This is an indication that the people did not support their home product. During 1928 the American films accounted for 95 per cent. of the Spanish market, whereas Germany, France, and the home market accounted for practically the remaining 5 per cent. American motion pictures have been successful abroad primarily because they please the ultimate consumer and not because of the free market that was extended to the motion picture industry in years gone by. Our cinema commodity was preferred throughout the world because it was the best motion picture made and because it struck a responsive cord abroad.

In the final analysis, it is obvious that in the export trade, just as in the domestic, the consumer will be the final arbiter as to whether American films are desired abroad or not. It is therefore the business of the American motion picture industry to make available to motion picture patrons throughout the world a product that will interest them, whether they are silent or in dialogue. If this is accomplished producers will hold a fair share of the world's business regardless of nationality.

Because foreign countries are making it more difficult for the American product to enter their boundaries profitably, American producers should meet this condition by close coöperation, by effecting economies abroad in distribution, and by continuing to produce motion pictures of a type that will be sought for by the people of such countries. To create a spirit of friendliness the American motion picture industry should coöperate with the other nations

in the promotion and distribution of a worth-while product manufactured in the United States. European producers should be permitted to familiarize themselves with our methods and should be given information which will permit them to acquaint themselves with the requirements of our markets. That, of course, may appear to be an unwise thing to do, but it is extremely valuable from the standpoint of encouraging and fostering a friendly international relationship that can result only to the advantage of the American motion picture producer if he continues to create the best article to be had. On the basis of so thoroughgoing a coöperation, the United States would in all likelihood continue to get its share of the world market. Such a coöperative spirit will result in a broader attitude toward the American motion picture by most countries. This may go further to remove the artificial trade barriers and obstacles that are being maintained than any attempt to meet the problem through stubborn aloofness.

It might similarly be to the advantage of the American industry to be represented abroad by capable representatives who not only would devote their efforts to encourage the broader development of the motion picture, but would be a source of information to foreign producers as to American methods in production, distribution, and exhibition. Such a movement, if properly conducted, would eventually invite confidence and coöperation by foreign producers and countries. In the world markets American producers can afford to take a chance on obtaining their proportion of the business that their product and enterprise may merit.

There is no longer any doubt, at any rate, about the place that the motion picture with dialogue will occupy in American entertainment. And, for the time being, in most instances, the foreign market must content itself with silent versions of the American dialogue motion pictures

that are produced. Such silent motion pictures will include musical accompaniment and sound effects, and these should continue to find a ready market until such time as foreign producers become familiar with the use of sound recording equipment.

Some effort will be made by American producers to cater specifically to certain countries. Marking one of the first steps in internationalization of talking motion pictures, Irene Bordoni, legitimate stage star, is appearing in a motion picture in which she sings in German, French, Italian, and Spanish, as well as English. In the making of *Innocents of Paris*, featuring Maurice Chevalier, a French version has been made as well as an English one, in addition to a silent one for general consumption in other countries.

The song motion picture probably has a chance of pleasing foreign audiences, and music may help to carry the appeal of American synchronized films for some time to come. The presentation of Al Jolson in *The Jazz Singer* created a favourable impression when produced in Paris. At Glasgow, Scotland, sound was introduced through the medium of *The Singing Fool* and was received favourably. On October 26, 1928, Londoners saw their first complete talking motion picture, *The Terror*, which, however, was not received with too much enthusiasm. Songs and symphonic scorings are understood by people of all nations. Any mother will recognize a lullaby, whether it is sung in English, German, French, or Russian. The natives in distant Africa have an appreciation of the unruly rhythm of an American jazz band. Grand opera supplies the best example that music has a universal appeal. During the operatic season one often hears scores sung in three or four different languages. The fact that they are not sung in English does not lessen the enjoyment of music for true opera lovers.

There are those who feel that American-made English pictures may not appeal to British audiences, but one of the most forceful London film critics, who has never hesitated to attack an American picture if he felt it deserved it, has expressed himself as follows:

> Let us get rid of this cant about the "English voice" and the "American accent." A good microphone voice with personality behind it is good to listen to no matter what its nationality or accent. In the matter of unpleasant voices and accents, English can claim no superiority over America. The American voice, at its best, is charming, especially Southern varieties of it. I have heard in England countless voices with audience quality far inferior to those of many American players whom we are getting to know by speech as well as sight.

The same interest in the sound motion picture exists among motion picture producers in foreign countries as among Americans. The more influential and constructive minds abroad feel that the sound and talking pictures have come to stay, and they are developing plans in order to meet the needs of their countries. There are, however, authorities who do not share such enthusiasm. Max Reinhardt, the eminent stage producer, recently completed a production in which sound, but not dialogue, was used. "I see two dangers in talking pictures," said Reinhardt. "One is that the films, which are universal in appeal, and really international, can only tend to be destroyed as an international art through the addition of the limitation of language." Mr. Reinhardt also declared: "The spread of the English language throughout the world has been so remarkable in the past decade that I feel that if ever there is to be an international language it is very likely to be English rather than any of the substitute languages devised by professors of universities."

Through the impulse of Premier Mussolini the Italian Parliament has provided official funds for the production of talking motion pictures, according to information received from the Department of Commerce at Washington, D. C. The net profits of the government-controlled company are to accrue to the War Cripples' Fund. Apart from this production enterprise Signor Mussolini believes that the venture will help to develop the Italian motion picture industry.

Dialogue motion pictures have been given official attention through announcement in London that the British Board of Film Censors will continue to act as sole censors of talking and sound films, as well as silent motion pictures. There was some question as to whether the Lord Chamberlain's Theatrical Censorship Department would undertake to review talking films, but it was finally decided the latter shall be judged the same as the silent ones.

Rapid progress is being made abroad in the development of modern sound apparatus and in the use of American sound systems. At the present time there are four German systems by which sound and film are synchronized. These are known as the Tri-Ergon, the Messter, the Kuschenmeister, and the Tobis, all of which are interchangeable and operate on the disk as well as on the film principle. In France, the firm of Jacques Haik has announced a new sound device to be called "The Cinevox-Haik," which it is understood will use both the disk and sound-on-film systems.

Western Electric equipment has already been installed in foreign countries. Such installations have been made in the UFA. Palace, Berlin; the Madeline Cinema at Paris; the Regal in London; in Glasgow, Scotland, and other important European cities, and in Sydney and Melbourne, Australia, where the introduction of sound has created tremendous interest. Further inroads have already been

made in India, Burma, Cuba, and West Indian islands. The first equipment installed in British India is in operation at the Elphinston Picture Palace in Calcutta. Other equipments are in operation in Kingston, Jamaica, in Panama City, and in Costa Rica. In Havana the first equipment has been installed in the Fausto Theatre.

The R. C. A.-Photophone has likewise already made a complete survey of conditions in foreign countries, as a result of which the installation of Photophone will be effected in principal cities throughout the world. It is expected that the manufacturing for Photophone may be located in Europe. The DeForest Phonofilm recording apparatus is now installed in studios in Australia, Spain, and the Argentine. So it may be inferred that American manufacturers do not propose to overlook the foreign market but to follow it as keenly as in the past.

Any other course, in fact, would prove impossible. However sharp the competition, however great the reduction of trade balances, isolation is out of the question. We shall not merely continue to participate in world trade but shall increase the measure of our participation. That is what the phrase "world trade" implies—an ultimate, if gradual, elimination of geographical boundaries under the erosions of commerce. At present, no doubt, the pressure of change makes itself apparent in friction and resistance. But the forces of evolution are not to be gainsaid; they will push ahead to their end in the unity of the economic scene. They can be halted here, turned back there, but not stopped. The United States will be part of the movement because it is part of the race; it will lead because it is young, resolute, brainy. We may render to scoffers and doubters our gratitude for sobering rash and ill-considered hopes; we cannot look to them, however, to point our way for us.

There will be our agents in other lands. There will be

our representatives constantly sailing and flying from capital to capital, showing our lines, taking our orders, watching our chances, pleading our cause. Hundreds of single figures, tracing the paths of fortune for the American film in every corner of the globe, they will come and go, these merchant adventurers; their ranks will be redoubled in their time and replenished after them. Through countless negotiations they will gradually build anew. Whatever of the past they must discount they will compensate for in the future. One must visualize that future not as a to-morrow but as To-morrow. Very likely the day will come, though many, many days intervene.

Since it is business of which we speak, the best attitude would seem to be the businesslike. What I mean is that we must study conditions, check them constantly, plan in a large way, and execute our plans to the immediate maximum. Even granting that at last we may find ourselves losing some ground, there is of course no excuse for relinquishing it in advance. Then, too, it is unflagging pursuit that brings one to fresh opportunities. Should such arise we need have no fear that we shall not win our allotted share of them. Such has been our history from the beginning. There need be little apprehension that our destiny is to suffer a radical defeat—not in the immediate future, surely.

CHAPTER XVI

TELEVISION

I. Television and the Motion Picture Industry

Most of the gloomy forecasts concerning sound have been made on the basis of novelty or of difficulty in foreign distribution; but more recently others have arisen in connection with what seems to be the next innovation—television. The statement made in this connection is that before sound can reach its potential audiences television will snatch them away. Since I am not any too greatly impressed by the blackness of the picture thus drawn I wish to do my share in clarifying the issue. And since the criticism does contain a tiny grain of truth, in spite of distortion and exaggeration, I wish to point out how and in what ways, as I see it, television is likely to be a matter of concern to us.

That there will be some sort of problem no one can deny. That one phase of the problem, moreover, will somehow involve competition is likewise easy to foresee. A new amusement feature is almost bound to distract people away from the old, simply because newness affects us that way. Then, too, each diversion builds up its own following. In consequence the film industry must now look forward to a day when a rival attraction will call for the tactics of rivalry. There is at this moment a need of clear vision and close thinking on the part of constructive minds, for the highest resourcefulness, the readiest initiative will be required to

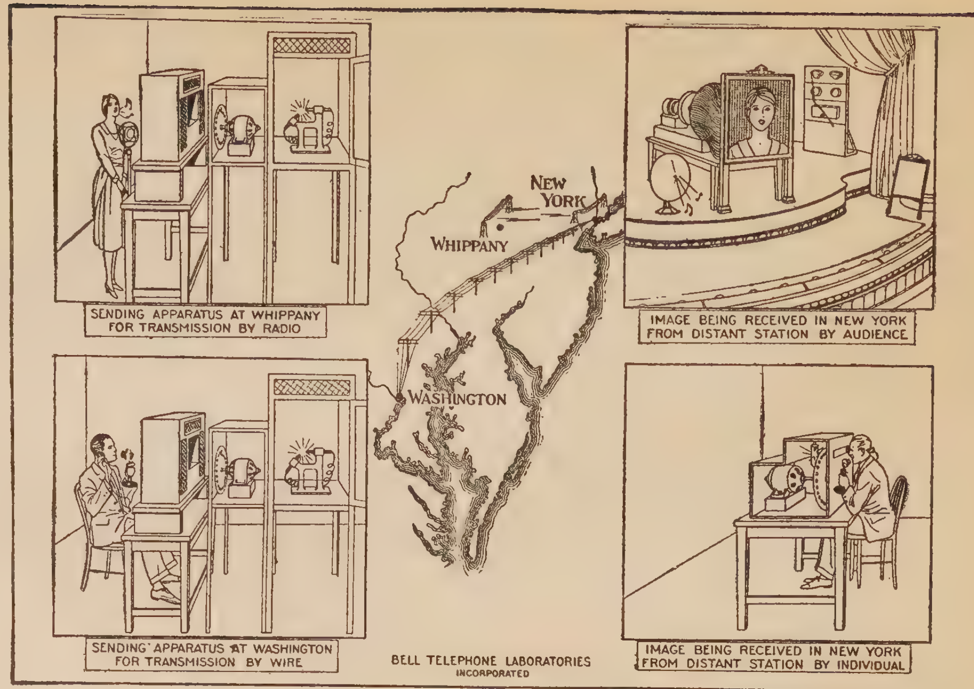

FIG. 12. SCHEMATIC ILLUSTRATION SHOWING THE FIRST PRACTICAL TELEVISION EQUIPMENT OF BELL LABORATORIES

offset the opposition that looms ahead in the distance. All this, mind you, without panic or pessimism; for although it is the opinion of some observers that the cinema may be quite seriously affected by the perfection of the newer device, there are not lacking others who insist that television will be an adjunct to the picture trade.

They base their prediction on the saving thought that television may develop new audiences for us. Nor need this reasoning seem utterly paradoxical. In the beginning radio broadcasting was considered a serious competitor of motion pictures; and in the beginning its perfection did affect box office receipts. Eventually, however, as the novelty of wireless wore off and it became part of everyday life, it helped the motion picture by cultivating a taste for entertainment in many who had not been entertainment minded before. In a like manner it is conceivable that motion pictures sent through television may act as a stimulant to cultivate a taste for the theatre in people who now visit us only on rare occasions. It is really not to be expected, after all, that the American family will be content to sit at the fireside at home and be entirely satisfied with the entertainment that may be sent through the air by means of television. Without arguing the point further, let me say merely that this fact is recognized by even so important an organization as the Radio Corporation of America, which is conducting laboratory experiments with television. Only recently the corporation has become interested in a theatrical enterprise involving many millions. It is thus only fair to deduce that those who are closest to television apparently feel that the motion picture theatre is here to stay.

Why not? People like to be seen by others, and enjoy being in public places. Here is a refined instance of "mob psychology," one which perhaps accounts for the universal preference to go where the crowds go. In every city, most

people congregate in the most popular place, whether it be a theatre, a dance hall, or a restaurant. There may be plenty of room in similar places away from the main stem, yet the public will put up with disadvantages, congested traffic, and other discomforts to be with the crowd. It is the same gregariousness that urges us to wear fashionable clothes so that we may be admired by others. Some social critics, indeed, believe that a great portion of those who subscribe for the expensive seats at the opera go principally to be seen!

Even when they are perfected, moreover, the subjects that may be shown through television will in all likelihood be limited. Certain events or the acts of important personages may be broadcast; but whether it will be possible to show a type of entertainment that requires a highly developed technique is still very much a matter of conjecture. The motion picture itself is merely an instrument of expression. It is the entertainment that it presents that interests the public, and not the fact that it is a motion picture. "The play's the thing." It may prove equally true of television. Producers who continue to present good entertainment need not be concerned with the inroads that the perfection of any device may eventually bring in.

Experience, quite on the contrary, indicates that in order to get the greatest enjoyment from a motion picture or other entertainment it is essential to be one of an audience. It is questionable whether drama or comedy, even though it be sent through television successfully, can register properly without the presence of a large number of people. Laughter is contagious; dramatic moments require a socialized reception to register properly. This statement may be illustrated by the fact that frequently we find it difficult to laugh at comedy renditions over the radio. The reason is not hard to find, for even motion picture producers are not able to judge a finished product until it has

been previewed at a theatre. Many scenes register differently from the way anticipated, and changes are made after the audience reaction has been determined.

The motion picture, however, should be prepared to face a readjustment period when television becomes practical. Most assuredly, in the beginning, the novelty will evoke wide interest. But after the newness wears off television will find its usefulness and its proper groove, and become just another comfort of modern life, as radio is. Not for a long time will it be able to offer home entertainment that will compare with the highly specialized technique involved in sound motion picture production. The present interest in television, as a matter of fact, is founded entirely upon reports of brilliant laboratory demonstrations. At the present time there is no means of satisfying the demand for reliable home television equipment, although no one doubts that the technical obstacles will eventually be overcome and that practical operation will become a fact.

At the present time, however, television is limited to sending crude pictures, consisting at best of but a few hundred image points. While the pictures themselves are very, very far from perfect enough to provide entertainment after the novelty has worn off, it is quite apparent that the progress that has been made so far is the type that is known as pioneering in a new science. Therefore, these earlier results must not be taken as indicative of the perfected form we anticipate any more than radio broadcasting could have been appraised originally by its early beginnings. An efficient and perfected television is almost certain to come because of the intensive research now in progress in the important electrical organizations. Building more elaborate transmitters is quite feasible, but this involves the utilization of enormously increased frequency bands for the transmission of the resultant signal. When

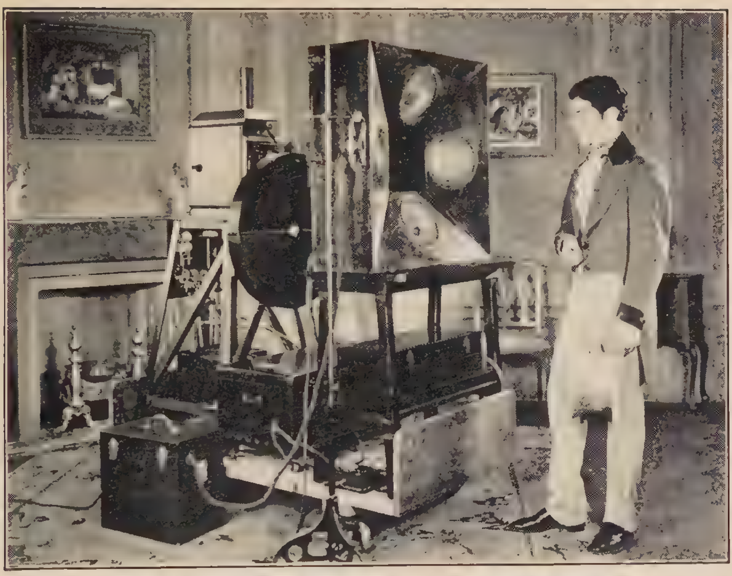

PLATE VIII. TELEVISION RECEIVING APPARATUS

the laboratory finally learns to combine visual impressions in the same manner that sound impressions are moulded into a single audio-frequency, great progress will have been accomplished and the end of experiment will be at hand.

There are some enthusiasts of television who claim that successful home installation is a matter of but months. However, in more conservative quarters it is held that thoroughly satisfactory results in the home will come, more likely, within two to five years. There are still others who protest that the development has yet to reach the comparative excellence attained in broadcasting when crystal sets were employed. Dr. Frank P. Jewett, president of the Bell Telephone Laboratories, and vice-president of the American Telephone and Telegraph Company, recently made the statement:

> At present television is entirely out of the picture except as an interesting scientific toy. It is wasteful, to the last degree, of communication channels. It is inherently, horribly expensive.

Thus at least one observer feels that the innovation is still in its infancy. Plate VIII shows television receiving apparatus. Another, Professor J. H. Morecroft, of the School of Engineering of Columbia University, is of the opinion that practical television will not be realized for many years. Yet the new science has opened wide vistas for experimentation, and we have seen such miracles in the past few years that public expectancy of an early commercialization is not surprising. The obstacles to satisfactory transmission and reception of instantaneous light are many, however, and until they have been overcome there will be few, if any, commercial television receivers. It is only the scientist and experimenter, with a wide knowledge of radio, who can obtain worth-while results with current equipment.

At present television is in the state of radio in 1908, or the motion picture in 1895; but that is no indication that we shall have to wait twenty or thirty years before events may be seen in our own homes. Progress moves faster these days, and in all probability there will be a rapid advance in the development of the new science. It has been comparatively rapid. Transmitters now send-

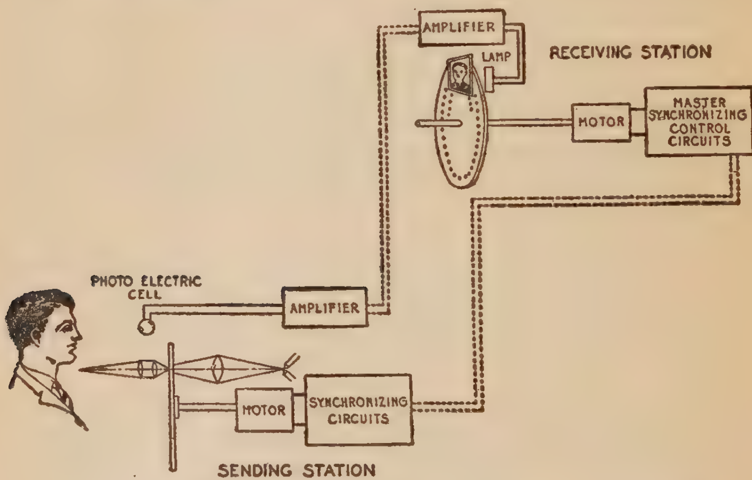

FIG. 13. SCHEMATIC DIAGRAM OF TELEVISION SYSTEM

ing out television programmes are few and are centred in the larger communities such as New York, Chicago, Boston, and Washington. Yet in the measure in which light transmission is taken up by more and more broadcast stations, greater development may be expected. It is to be expected that the future will stress the offering of many television components for the experimenter who, like the engineer, is faced with such problems as improvement in photo-electric cells, more sensitive relays, better amplifiers and neon tubes, micro-metric speed control of

the screen disk motor and others. Every study of television, however, seems to emphasize the fact that its appearance in the form of a truly practical commercial receiver or reproducer is some distance away. Still, the ultra-enthusiastic televisionist dreams of the day when he can sit in an easy chair before an open fire in his home or club, and watch a World Series or football thriller reproduced on a screen by radio!

More power to such dreams! They are the stuff tomorrow is made of. I, for one, would never join the ranks of mere mockers and scoffers, and I trust that time will never prove me to have been an obstructionist. Yet I must be pardoned if I seem not quite sanguine of immediate consummation. It is one thing to believe that an improvement will come to pass; it is another to expect that it will come to pass before breakfast on the morrow. My heart is with the hopeful; my head counsels me not to look for everything at once.

To conclude, then, I do not look for immediate readjustment within our industry because of television; nor do I fear any great loss through competition after the first wild rush. There will be a period of transition, just as there has been within the motion picture field; but as we have bridged this, so shall we that, and perhaps more quickly and safely for taking thought in advance. Until the race loses all social instinct the theatre need know no dread of extinction. Who knows, who can say, that television may not indeed make its home—or its bow!—in the auditorium? The radio, if you recall, was going to put the newspapers out of business. It has not, for the simple reason that people wish to read newspapers.

The public has shown that it likes sound motion pictures. My confident prophecy is that the public will continue to like sound motion pictures.

II. Television: Problems and Promise

We have been discussing the probable future of the innovation. But what *is* television?

There are three separate phases in the development. The first is semiphotographs by radio, which are now being effected every day in the course of regular business. The second is transmitting motion pictures by radio. The third is televising actual events. Until recently television has been able to show only stationary or slow-moving objects without blurring the picture. This defect, however, is being rapidly overcome. Demonstrations have been given in which images of two men boxing, fencing, and swimming came in with "fair clarity" over a band only forty kilocycles wide. Some stations have been successful in broadcasting very small pictures on a channel ten kilocycles wide in the broadcast band. One of the big problems pertaining to television is the selection of wave lengths most suitable for picture transmission. For adequate television service, channels one hundred kilocycles wide are essential. One may draw his own conclusions, therefore, concerning the commercial feasibility of the feats I have mentioned.

Until recently, moreover, it was impossible to send anything but highly illuminated scenes over the radio because the photo-electric cell, which is to light waves what the microphone is to sound waves, demands intense illumination. Those who are familiar with photography realize that the photo-electric cell—the eye of the contrivance—is exposed to the scene only $\frac{1}{50,000}$ of a second. It therefore was not possible to televise any scene in natural sunlight, or any scene with human actors except for very short flashes, because of the intensity of the light. The Bell Telephone Company, however, has devised a new system of television whereby it is possible to trans-

mit scenes taken in ordinary sunlight. The necessary brilliance at the receiving end is furnished by a series of amplifying tubes.

Again, most of the machines in this country are limited to a capacity of 40,000 light impulses a second. The situation is that of a motion picture projected at half the rate of the regular speed. Professor Karolus of Berlin has been able to project on a $3\frac{1}{2}$-inch screen because he has increased the speed to 80,000 per second. He believes that it is possible to speed up this maximum even further. If the reader is to have some notion of the problem in this connection he must bear in mind that to transmit a four-inch square picture would require 160,000 impulses.

A device for the transmission of moving pictures by radio, however, in which the size of the image transmitted is not limited, is reported to have been developed by a Luxembourg scientist in Paris. Although the transmission and reprojection of film by radio has been accomplished by various methods, the inherent limitations of previous experiments have prevented them, too, from assuming commercial importance. It is claimed that with the device of the Luxembourg savant the perfection of the image that is reproduced increases with the size of the screen. The use of a positive film is eliminated; the transmission is accomplished by using the negative film directly. This elimination is said to be an important consideration in the rapidity with which pictorial news items, for example, can be displayed after the original has been taken and the negative film developed.

Most of the transmitters now used are for pictures bearing twenty-four to forty-eight lines to the inch. The clearness of television pictures depends upon the number of lines to the inch, since those having more lines are more distinct, as in the case of a half-tone. Each television picture consists of a series of lines. These

are white on a black background and are similar to those of a newspaper photograph when viewed through a magnifying glass. Photographs in the usual sort of magazines average about one hundred lines to the inch, and some engravings printed on calendered paper run one hundred and fifty lines to the inch. On this basis one may make a comparison of television pictures with magazine photographs and may determine the state of progress in the new field. It would seem that there is quite a difference between a photograph a few inches square of a quality comparable to that of the ordinary newspaper photograph, and one that is eighteen to twenty feet in width, the size of picture shown in the modern motion picture theatre.

Much effort has been made, and is continually being made, to control static in connection with radio. The radio industry is making an effort to perfect wired radio so that programmes may be transmitted directly to the home over regular house lighting power lines. This step is of interest, for the idea is in line with the development of television reception, especially in connection with providing a means for the elimination of static interference. It may also be the means of determining a method for the collection of revenue from those who receive programmes. It is to be expected that, with this source of revenue, programmes over radio, as well as by television, will improve and will make available to all talent of a high order. It is fair to assume that audible radio and television will be definitely placed on a successful commercial basis so that the cost of engaging the talent is shared by those who benefit from it. At any rate, this is the plan in the minds of the men who are now intensively engaged in audible radio and television programmes.

Although television is still in its crude experimental stages some result may be obtained with home-built apparatus, which may be assembled at a reasonably small

cost. One may now construct a set that will bring in pictures, if it is properly tuned to and synchronized with the transmitting station that happens to be broadcasting pictures at the time. Though the images are not good enough for regular reception, moving figures and faces are faintly recognizable. Amateurs, in fact, were successful in bringing about interesting receptions during the past year over distances of five hundred miles or less. Pictures were received regularly during that period, and interference occurred only in thunderstorms during a few of the evenings when tests were scheduled. At times, furthermore, when ordinary radio signals were very weak and the static was so bad that the voice announcements could not be understood, perfectly recognizable images were picked up by television sets.

The system that shows immediate promise for the home constructor is that which is known as the "scanning disk." This disk, which is sometimes called after its inventor, Nipkow, who patented it in 1884, makes possible the decomposing of an image into a large number of small images for the purpose of transmission. A number of holes are drilled near the outer surface in a spiral. The number of holes in the disk determines the number of vertical or transverse divisions in the picture. To secure the best clarity or definition with a given number of small images, or "dots," as we call them, the width of each dot should equal its height. This makes it advisable to have a square image. Since the number of holes in the disk determines the number of dots in one direction, and since the picture is to be square, it follows that the total number of dots is equal to the square of the number of disk holes. If, for example, the disk has forty-eight holes, then the image will be decomposed into forty-eight times forty-eight, or 2,304 dots at the transmitting end. The receiving process recomposes these 2,304 dots of differ-

ent intensity into an image. These must be reassembled or composed in the same order and at the same speed that obtained at the transmitting end.

Although the eye is a very remarkable mechanism in many respects, it is faulty in that it has what is known as "persistence." This means that the electro-chemico process taking place in the nerves and the brain as a result of a stimulus on the retina persists for a brief time after the stimulus has been removed. Persistence lasts for about one tenth of a second; so if a series of stimuli are applied at that interval the result will be, not a broken, but a continuous reaction. It is this defect that makes possible motion pictures and television, since the illusion of motion is produced by sending a series of pictures, each of which is a "still," at the rate of ten or more a second.

To make the illusion more perfect, more than ten images should be completed every second, and from fourteen to sixteen are found to give almost perfect results. For reasons which will become clear as we progress, the lowest possible number is taken both as the minimum and as a value that will be satisfactory for television in its present imperfect stage.

We noted above that the disk with forty-eight holes produced an image with 2,304 dots. Having also concluded that ten images should be sent each second, it follows that 23,040 dots a second are required. This is equivalent to a requirement of 23,040 electrical impulses of varying intensity every second. What we have here, then, is analogous to the problem of transmitting an orchestration in which the frequencies extend up to 23,040 cycles a second, or considerably above the audible range for the average person. When it is realized that modulating frequencies of even 5,000 cycles, and even the average audio-frequency amplified seriously, discriminates against frequencies above 6,000 or 7,000 cycles a second, the

problem of transmitting and receiving an image such as we have described can be appreciated.

Let us see what sort of a picture is possible with 2,304 dots. Many newspaper cuts are photographed through a number 60 screen, which means that there are sixty transverse and sixty vertical rows of dots a square inch. This means that there are 3,600 dots a square inch. If our image has the definition of the average newspaper picture, then it can cover about two thirds of a square inch. To keep the same definition and increase the image size requires the transmission of a greater number of dots. This is objectionable for several reasons. In the first place, the above picture requires a transmitting band of approximately 46,000 cycles, or 46 kilocycles, since the carrier is modulated by 23 kilocycles on each "side band." This encroaches severely on the available channels, and the Federal Radio Commission is now establishing regulations to govern television broadcasting. Then, too, the transmitting and receiving equipment require very special design to make our project possible. If the number of dots is greatly increased, with a necessarily corresponding decrease in the interval for each interval, the limiting time required for the production of a reaction from the light stimulus is exceeded, and the image is not seen!

If, on the other hand, the size of the image is increased without increasing the number of dots, the definition becomes poorer. If the picture is to be 1.5 inches square, the 2,304 dots must be spread over this area of 2.25 square inches, giving only about 1,000 dots a square inch, or the equivalent of a 32 mesh. This still is a reasonably good definition. It is actually an indication of what may be expected in the near future in both definition and size.

Working at the problem from another direction, let us suppose that we are to stay in the 10-kilocycle band allotted to each station. This permits us 5,000 cycle

modulation, or 5,000 dots a second. This again means 500 to an image, or about twenty-two rows of dots. Even if the image is only an inch square, the definition is rather poor; and if the image size is increased to 1.5 inches square, the definition is correspondingly poorer. Thus we see that the method which makes possible home television as it is to-day, at the same time introduces limitations which make it virtually impossible to transmit large images with the fidelity secured, say, in motion pictures. For the development of television, as the optimistic dreamer sees it, some other very different method must be introduced.

Motion pictures were indeed broadcast through television in January, 1929, by WCFL, the broadcasting station of the Chicago Federation of Labor. Though silhouettes and small objects had previously been broadcast, this was one of the first attempts to put a motion picture on the air. The feat was achieved by a device which passes the film before a beam of light that scanned it from left to right. The light images were then converted into electrical impulses which were amplified and in turn converted into radio-frequency impulses. For the reception of these motion pictures there was used a standard television reproducer consisting of a 48-hole disk revolving at 900 revolutions per minute, scanning from left to right and top to bottom. The output of the receiver included a detector tube, which fed into several stages of a resistance coupled amplifier; and the output in turn fed into a neon tube set behind the disk. A "movie" approximately $1\frac{1}{2}$ inch high appeared on the receiver's disk.

On February 5, 1929, engineers of the General Electric Company made a very interesting television broadcast over long distance, in which the voice and face of D. W. Griffith, the director, were transmitted from their station WGY, in New York, to Los Angeles. A short wave of

21.58 meters over their experimental station 2XO was used for the face signals, and a wave of 31 meters over station WGY was employed in transmitting the voice. A new television record was established more recently. Images broadcast from station 2XAL, in New York, were received by an amateur in Johannesburg, South Africa. The images received were fairly clear. Production of short-wave television sets on a commercial scale has been announced by the Jenkins Television Company. Silhouettes are now being broadcast by the Jenkins Radio Station in Washington, D. C. Television experiments are being conducted by the laboratories of the large electrical organizations. They will eventually result in a practical and simplified system of sending images accompanied by sound with the same degree of flexibility as that of radio broadcasting.

Many patents have been granted by the United States government to workers in the field of television. This activity would indicate that the final development of the art will result in patent litigation similar to that which characterized the early history of radio.

I believe that my necessarily brief (but not, I hope, otherwise inadequate) statement of the facts should clinch the contentions made earlier in the chapter. Television has a brilliant future but not one which will come in weeks or months. In the years directly ahead sound has no obstacle to intrenching itself solidly with the public. Given such a start, it should devote itself to the kind of product that will hold fast the affections of theatre-goers. If it can do that it will survive the first shock of rivalry. Perhaps it will even survive the rival! Perhaps it will form some sort of partnership. Perhaps it will go down in defeat. Perhaps—but that day is not now, for to-day is the day of sound. And much, too, I feel sure, belongs to it of to-morrow.

CHAPTER XVII

THE FUTURE

I. A Brief Retrospect

Throughout the text references have been made to the future, since it has been beyond human reserve to resist the temptation to do so. Even though I anticipated this chapter as my conclusion, I was frequently forced to run ahead, because of the very nature of my theme. When anything, like sound, has the majority of its life ahead of it the interest is bound to turn to the probable next step, or the grand outcome. The excitement of what may or may not be expected gives the mind a third dimension of untold length. No occupation ever seems quite so solid, so real, as the one still unfinished.

In a sense, then, this book is more a prophecy than a record, for most of it is forward looking. The best proof of this would be, illogically, to halt for a brief review. In Part I, I told the tale of the past (chapter I) merely to provide a background for the contemporary scene; and I broke off at the end of chapter II only because to-day is ever brief and can be finished only when it becomes to-morrow.

In the second division I did, it is true, explain the mechanism in the theatre as it is now constituted. In my exposition of the standard sound devices and their operation (chapters III and IV), in my popularized résumé of acoustics (chapter V), in the manual (chapter VI) and its pendent on maintenance (chapter VII)—in all

these I described the actual, the existent, as I know it. Yet even there some detail still in process sent me flying forward into conjecture; and above all, I knew while I wrote that my words were less for present operators than for others still to come.

Of Part III, surely, the statement is doubly true. At every point in the consideration of the studio (chapter VIII) and of production generally (chapter IX) we are in a world of still-to-be. As for our knowledge of the fundamentals of speech, music, and hearing (chapter X), we admittedly have much to learn.

The same air of expectancy held throughout the discussion of auxiliary elements. I am sure that the reader felt, as I did, the electric tingle of change that has made itself evident in advertising (chapter XI) in the employment of music (chapter XII) and in the complete overhauling of the short subject (chapter XIII).

And this, the concluding section, is compact of that conjecture and speculation which is the very breath of novelty. When we are totally without precedent in action, prophecy ceases to be mere gossip and becomes the closest approximation we can find to fact. I therefore make no more apology for what I have written here than if I were throwing a searchlight into dark uncharted places on a voyage of discovery. Guided by experience and reading I have summoned imagination and common sense to peer on as far as the eye can penetrate; for I know how much, at this stage of the game, people are interested in possibilities rather than performance. If I have succeeded at all I have lent steadying reassurance to the prospect. As I said in the fourteenth chapter, sound seems to me to have commercial potentialities yet undreamed of. Even in two connections where some threat of difficulty arises to trade abroad (chapter XV) and from television (chapter XVI) I cannot admit that the road is in any

way hopelessly blocked. The situation is delicate in the one case and problematical in the other, but that is all. I see no obstacle which gives actual ground for fear or which forethought and vigilance may not surmount.

We may take our cue from the lone eagle among the aviators. His great feat accomplished, he turned to different directions, not in panic over perils still to be met, but with confidence born of achievement. So we, who have safely ridden the convulsion in which sound was to give the death blow to the industry, might well yearn for new worlds to conquer, new impossibilities to tame to our will. Let those who are exhausted or hag ridden drop to the rear, where their nervous lamentations cannot annoy the leaders. We have not revolutionized our domain in a year merely to be plunged into chaos by neurotic soothsayers promising defeat. In that year we altered every aspect and division of our domain. Production, distribution, operation—not one remains what it was. Defeatism is impertinence; we have work to do. And in the contemplation of the tasks that confront us—and in no mere pep-rally enthusiasm—I ask the reader to bear with me yet a few pages more while I point out the realities of a to-morrow, not doomed, but impatiently awaiting our clear thought and our active creation.

II. Some Agenda for the Near Future

In the opinion of D. W. Griffith, pioneer motion picture director, talking pictures within the next five years will supplant both the silent drama and the spoken. Although the prediction may perhaps be overoptimistic, sound motion pictures with dialogue, singing, music, and incidental effects will doubtless make very important strides. The dialogue picture has the superiority of all the action of the silent film, plus speech and sound of every description,

with the invaluable distinction of music perfectly attuned. Another great advantage which talking pictures have over the stage is their ability to present every word so clearly and distinctly that no one need strain to hear what is being said. A whisper is clearly audible from the front row in the orchestra to the last row in the balcony. Let me then offer my own opinion that when dialogue pictures reach the degree of perfection now enjoyed by stage productions the latter are going to suffer by comparison.

In dramatic art vocal interpretation and accompanying action have in the past proved superior to pantomime as instruments of expression. On the speaking stage pantomime is a mere shell for the voice, for only the few in the front rows are close enough to get that full play of pantomime that the screen is able to show to an entire audience through the use of the close-up. On the other hand, voices in themselves, as in the radio and phonograph, are capable of making a wide appeal. Not until we arrived at the talking picture, however, was it possible to combine the best qualities of pantomime with the advantages of the spoken voice.

The manufacture of sound motion pictures has, for one thing, passed the stage of mystery. Those engaged in the business of making such pictures are now familiar with the medium. Many technical words coined because of sound have already become a regular part of cinema vocabulary. There is now a feeling of confidence about the studios that was lacking in the beginning. Technicians and players are available in sufficiency. They have a full realization of possibilities and are equipped to use their knowledge to advantage. Moreover, practically every important producer is now engaged in the new venture. We have learned that the entertainment and artistic value of the silent technique need not be sacrificed in the adaptation of sound. What is more, each new sound

motion picture will show improvement. There have been some definite expressions against the all-dialogue pictures, but these arise as criticisms of the imperfections that may be expected in any beginning. Of course, certain stories or subjects that do not lend themselves to dialogue will continue to be made in silent form, for the public will be hospitable to silent motion pictures as readily as to talking pictures provided they are of good quality. There is no conflict between the two; each has its place, and both will meet with the success that they deserve. At this writing, the leading producers have shown marked improvement in the all-dialogue pictures recently shown. The splendid productions of *In Old Arizona* and *The Cock-Eyed World*, produced by the Fox Film Corporation, were successful principally because they were remarkable entertainment. Metro-Goldwyn-Mayer's *The Broadway Melody* and *Madame X* are other notable examples of the rapid strides that are being made; and such pictures are but hints of the progress that may be expected.

Under the new conditions it is likely that fewer productions will be made than in the past. It is an easy thing to turn out a number of silent motion pictures that require only titles to hold a story together. But when a story depends on intelligent and continuous dialogue the richest capabilities of writers of drama will be taxed. It is difficult to imagine anything as annoying as inept or meaningless dialogue. Where the silent motion picture left something to the imagination of the audience, a dialogue picture, to be acceptable, will have to absorb the full attention of the auditor. Good writers will become more important than in the past; and though it is likely that those who have been writing titles for the silent motion picture will be in demand as writers of dialogue pictures, their dialogue will probably be part of their own stories, for the new art will demand an author's creation. The in-

dustry would do well to foster a school for playwrights and otherwise to encourage writers of talent. If interest in the legitimate theatre is diminishing, it is because of the lack of a sufficient number of good dramatists to go around. Good story material will be the most important requisite in time to come for the dialogue motion picture, because a picture is never better than the story it tells. The all-dialogue picture will evolve an entirely new literature for the screen. It will express film drama never before possible.

A new musical interest has been added to the sound motion picture. Scores adroitly arranged, that interpret each situation, together with cleverly written theme songs, have added considerable entertainment value. But the art of scoring motion pictures under the new order of synchronization has scarcely begun, and important strides may be expected in this connection within the next few years. But even at the present writing one may say that music, as synchronized, is in closer unity with the situations pictured than was the case in former times. There is not, moreover, the distraction caused by the close proximity of musicians to the screen. The small towns, where inadequate orchestras used to render their ineffectual accompaniments to the silent pictures, have reaped the special benefits of musical synchronization. Music of the best calibre becomes available to every type of theatre. Legitimate theatres may now install reproducing apparatus to be used not only for the showing of special sound motion pictures but also for furnishing entr'acte music.

It seemed for a while that the question of interchangeability of sound-producing devices would rise to impede production and restrict competition. Since producers would be limited to those theatres using their particular system and to no others, and theatres, on the other hand,

would be limited to producers having the system that corresponds with the theatre's reproducing device, a serious hindrance to development seemed to present itself. Second, that manufacturers and their producing licensees are disposed to permit their productions to be played over any system, *provided it gives a grade of reproduction equal to that of standard equipment.* This is obviously fair and reasonable, since in the long run it does not benefit a producing organization to have its recordings played over equipment that is inherently incapable of giving a good enough reproduction to do proper justice to the original. Nor does it benefit the manufacturer whose recording equipment was used. As these considerations become accepted by the industry, the interchangeability matter will probably dispose of itself naturally. Neither has progress in this respect always initiated with the leaders. The independents, too, have made an important contribution which resulted in an open market and in the development of low-priced equipment through such organizations as Phonofilm, Sonora-Bristolphone, Powers' Cinephone, Biophone, and Pacent Reproducer. These organizations deserve great credit for their resourcefulness and enterprise.

There is no denying, however, the fact that the present condition in the industry, in which studios and exhibitors have the choice of sound-on-film and disk methods, is one that invites duplication of effort. Standardization will eventually eliminate one or the other, and it would appear that the system of recording sound on film will ultimately be the standard adopted by the picture producers. The advantages of the sound-on-film method are many; economically, it is the safer and surer method. When the sound is recorded as part of the film itself we eliminate the possibility of mistakes in shipment or in handling —a possibility that is always likely to arise in connection with the disks. Furthermore, the sound-on-film system

is handled much more easily in the projection booth, and experience indicates that fewer surface noises result when this method is used.

The sound motion picture has met with greater success in theatres of medium seating capacity (2,500 to 3,500 seats), and this fact may have a marked effect upon the design of newer theatres; for while satisfactory reproduction has been attained in theatres of huge seating capacities, yet the problem in such houses is so formidable as to require constant and minute supervision. Auditoriums, it goes without saying, will be specially designed with the greatest regard to acoustical conditions, and we may well expect—except in theatres located in the very largest communities, where stage entertainment may be expected at some time to be a part of the programme—to see the elimination of the present size stage with its lofty gridiron. Projection booths have already become the subjects of special study by theatre architects and engineers. In some of the Fox-West Coast Theatres, for example, a special observer's box is provided in a balcony close to the booth, so that projectionists may see and hear everything just as it comes to the audience. Experiments are now being made looking to the substitution of remote controls for the present methods of booth operation. Such controls, were they mounted on a panel, would make it possible for the projectionist to control the volume and tonal quality of sound from the vantage point of a place in the audience.

In a different direction good technical progress has already been made and reported by the Society of Motion Picture Engineers. Such accomplishments have been effected in connection with colour photography, motion picture cameras, laboratory equipment, illuminants, projection room equipment, stereoscopic pictures, and television. No one can doubt that with the development of sound synchronization science has entered the entertain-

ment field. It is only to be expected, then, that the great electrical organizations will take an ever increasing interest in the future of the industry. Organizations such as the American Telephone & Telegraph Company through its subsidiary the Western Electric Company, the General Electric Company, the Westinghouse Electric Company, and the Radio Corporation will further encourage the development of sound and will make available to the public the resources of their laboratories. In view of such resources the possibilities of motion picture entertainment may be said to have scarcely been scratched. Newer methods and revolutionary improvements will come in direct ratio to the scientific facilities applied to them. This should eventually mean the solution of other possible riddles, such as stereoscopics and the further development of natural colour. The possible future of the motion picture screen, with animation, sound, colour, third dimension, and screen magnification, gives unbounded play to the imagination. Eventually there will be such perfection along these lines that one entering a theatre and seeing such an exhibition for the first time will get the impression that he is actually seeing and hearing living people in action!

Already we have sound, colour photography, and the large screen. A film, double the width and one and one-half times the height of film in current use, has been developed by the Fox Film organization, and is known as "Grandeur Pictures." By this means an image may be extended throughout the proscenium opening. To bring the innovation to the public, it is true, will require important changes, involving a new camera and projector, as well as new screens. In production, the optical and photographic principles involve a new technique in construction, as well as lighting; but all of these have been perfected. For a number of years George K. Spoor has also fostered experi-

ments in connection with a wide screen and has perfected a camera and a projector to accomplish his end. It appears that the wide film eliminates distortion. Furthermore, this type of picture presents new opportunities in effects and photographic values. Such apparatus must not be confused with the magnified screen attained by use of a magnifying lens, as employed in projecting certain scenes of *Wings*, *The Big Parade*, and other great film creations.

The time may come, and that in the near future, when the screen itself will be the loudspeaker, eliminating the necessity of horns, dynamic cones, or any of the present equipment used for the purpose. Experiments along such lines have already been undertaken by one of the important laboratories. Another effort that has been made is to devise an instrument through which it may be possible to replace or substitute a voice on talking picture films. With such a process it may be possible to revocalize American-made films for foreign languages, very possibly a great aid in catering to the market abroad. This device would also permit utilizing the voice of a gifted player for other performers good in screen personality but deficient in vocal quality.

It may be expected that in due time and with the development of cameras free from objectionable mechanical noises, the so-called camera "tanks" will be eliminated. Already important experiments have been conducted by several of the studios looking to the improvement of "shooting" scenes by substituting the use of the portable tank. Some success in this direction has been achieved by placing a portable box over the camera; the box having the effect of muffling the clicking of the mechanism. The camera is mounted on a tripod, as heretofore, and a housing of soundproof materials encloses the camera box.

The highest technical perfection, however—stereoscopics, or the third dimension—is still lacking, although

many important minds are concentrating on the development of the feature. So far as the projection of "still" pictures is concerned, this can already be accomplished by any one of a great number of devices placed at the eye; for the essential of stereoscopic vision is the existence of two images corresponding to what each eye sees, and the segregation of each image to its proper eye. There have been some claims of stereoscopic features in connection with the introduction of the double-width screen. However, although such screens are of value in reproducing larger images and securing larger area, they do not, up to this writing, include any stereoscopic advantages.

Dr. Herbert E. Ives of the Bell Telephone Laboratories has evolved a plan wherein a spectator at one side of the theatre sees a different side of a certain object than is viewed by another spectator on the opposite side of the room. Thus he gives the illusion of solid objects in space instead of flat images on a flat surface. The apparatus necessary to attain the desired effect, however, is both cumbersome and costly. To obtain the result, projection is placed behind the screen, which is transparent; and the spectator is seated on the opposite side of the screen. Both sides are blanketed with grids of alternate opaque lines and open spaces that pass the light in narrow parallel bands. The projectors behind the screen are arranged in a semicircle. All of them render, simultaneously, views of the same scene taken at one time by a battery of cameras arranged to focus on their objective from different angles. Using the present motion picture camera, it is necessary to take sixty images each from a slightly different angle; the procedure requires fifteen cameras with four moving lenses, each photographing about eighty pictures a second—more than four times the ordinary rate of speed. The sixty images taken are then all condensed upon a single film. Dr. Ives knows that photographers will say that the ob-

stacles are insuperable, but insists that if sufficient diligence and the same kind of financial backing and facilities that have been given to similar developments are given here, the difficulties of simplifying the projection and restoration may be overcome. The experiment is particularly interesting in view of the fact that Dr. Ives has to his credit the origination and the present progress of television as developed by the Bell Laboratories.

What about sound itself? An indication of the possible future is the fact that recently the American Telephone & Telegraph Company transmitted actual pictures of an actor's voice, sent by telephoto from Los Angeles to New York in seven minutes. Three words—"Is that so?"—were spoken in Los Angeles by William Haines and photographed in sound strips, and were later divided into separate pieces the size of an ordinary photograph. Transported across the country in this manner the individual pieces were put together in New York and the words were incorporated in the scene of a picture that was being shown in New York at the time. Eventually science will certainly develop wireless telephony and television beyond our present imaginative expectations. When they are fully developed a person sitting at home may be "present" at any event, regardless of distance, at will. Stereoscopic television in full natural colours, and perfected wireless telephony, will enable him to see and hear any event that is broadcast as effectively as if he stood beside the transmitting apparatus.

The dialogue motion picture is also likely to have an interesting effect on the theatregoing habits of its public. While it has meant nothing, until now, to drop in on a picture after it started and then pick up the threads of the story as it progressed, in the case of the talking picture it becomes more important for the audience to be present from the beginning. If the talking motion picture follows

the technique of construction in play-writing, the earlier part of the action, in a measure, will establish the premise for the story that is to come. If this is missed, it is obvious that the picture will not be as enjoyable as though it were seen from the very beginning. Hence it is likely that, in neighbourhood theatres, managements will establish definite schedules for the feature portion of the programme and try to regulate the attendance of patrons. The problem is of importance in connection with downtown or de luxe theatres that depend to some extent on transient patronage. Conspicuous posting of schedules and advertising of the starting time of the various units of the programme will help the public to view the talking motion picture from the beginning.

It becomes more important than ever for management to impress upon patrons the necessity for silence so that all may clearly hear the spoken word. In the Roxy Theatre, New York, signs reading "Silence," in electric lights, carry the message at every turn. Special trailers, emphasizing to patrons that silence adds to everyone's pleasure, are a direct means in focussing the attention of patrons to this social amenity.

The dialogue picture has already worked a change in the attitude of moving picture audiences in regard to applause. Observations would indicate that audible pictures are more likely than silent ones to move audiences to applause. Though sound and dialogue pictures are now known by various names, it is expected that the American public will ultimately call them all "talkies."

With the development of sound, Los Angeles and its suburbs are likely to increase in theatrical importance. Sound will attract to the studios located there artists and writers of the greatest ability, because sound pictures, made for a world market, will promise financial rewards too great to be resisted.

A question has been raised as to what will happen to the de luxe type of entertainment, where stage presentations have become an important part of the programme. It is safe to assume that the same patronage that made necessary a different type of entertainment for the high-priced downtown theatres as compared with those that play pictures subsequently will continue to demand it. Therefore theatres of large capacities in key points, and charging higher prices of admission, will in all likehood continue the stage type of entertainiment regardless of the success of sound motion pictures. Such stage presentations will always improve in quality and will keep pace with public expectation. The use of the ultraviolet ray for novel lighting effects on the stage will be one development in connection with stage presentations. Trained on a stage scene, these rays transform the natural colours of the objects to delicate new shades and hues.

Dialogue motion pictures have renewed the vexatious question of censorship. To begin with, censorship is against the principles of the Constitution of the United States, which specifically guarantees the freedom of expression to rostrum and press. It is fair to assume that had the authors of the Constitution foreseen the motion picture and its further development through sound, provision would have been made to allow the fullest expression. The newly acquired voice of the screen is entitled to the same consideration as that accorded other arts. Censorship is an un-American institution and gives bureaucratic power, in many instances, to a prejudiced minority. Yet news as heard from the screen and speeches of world-wide personalities delivered on important occasions are now subject to some of the censorship regulations.

Enforced censorship of sound motion pictures in different communities would bring to the industry serious problems in the physical handling of film. Changes required by

local censor bodies cannot be made as readily as in the case of the silent picture. Although correcting scenes in the silent version to meet the demands of the censor boards is a simple matter the problem is a big one when it is applied to sound. A title can be either rewritten or eliminated; a scene can be cut out; a title can be substituted to explain the deleted action. Such methods are not possible in films that are synchronized with dialogue. They mean a return to the studio and a fresh production. The cast and the set must be recalled to retake the action. In some instances members of the cast are not available when needed for such retakes, so that the effect on general releases in censored territory is virtual obstruction.

A situation which might be considered perfectly good in forty-seven states can be barred in one, because of the dissenting opinion of the censorship board in that state. The action of such a censor body necessitates the remaking of the scenes objected to and involves a cost of many thousands of dollars before the picture may be released in that state. When it is fully realized that censorship of speech from the screen is an assault on the most sacred rights guaranteed by the Constitution the practice will ultimately be abandoned. In the meanwhile, every constructive element within the industry will devote effort to the end that no picture is produced that will offend any reasonable person. It certainly seems unfair to allow freedom of speech to those who write for the legitimate theatre and to lay a handicap on sound motion pictures. If dialogue writers must follow the dictates of censor bodies, the dialogue in many instances would be unnatural and uninteresting and would be forced down to the level of a child's intelligence. This would have a tendency to affect the better effort of fine dramatists ruinously.

Recognizing the influence of the motion picture as important in the cultural development of the country and in

the study of art and science, the University of Southern California has given the cinema academic standing. In the 1929 spring semester schedule, along with university courses in literature, language, Latin, and law, is a new course, "Appreciation of the Photoplay," which has been bulletined between courses of philosophy and physical education. The university will offer the degree of Bachelor of Science in Cinematography to those who complete the course successfully. Qualified members of the Academy of Motion Picture Arts and Sciences, leaders of the industry, noted critics, and selected members of the faculty of the university, will give lectures on the subject. The course will cover the early history of the photoplay, its scientific foundation, its growth and development, the silent photoplay, the modern photoplay with sound and voice, the story, the actor's art, pictorial beauty, the principles of criticism, the social utility of the photoplay, its relation to the æsthetic culture of the world, and its future. A permanent reproduction by sound-recording devices of the selected lectures will make the course available to other institutions of learning. A library of a new literature, critical and analytical, as applied to screen art, will be developed. Students are to learn the photoplay as an instrument for portraying the best in science and art, in literature and commerce, in religion and recreation. Need I point out the significance of all this to American culture and education? It has been held, moreover, that the dialogue motion picture will have an effect on American speech. Indeed, it will eventually have the strongest influence. What that influence will be is in the hands of those who are entrusted with the making of the product itself.

The William Fox interests, which brought Movietone (the-sound-on-film method) to the industry, have already placed themselves in probably the strongest position as

producers, distributors, and exhibitors. The acquisition of the control of the Metro-Goldwyn-Mayer Corporation and Loew's, Incorporated, by the Fox Theatres Corporation, is the greatest single achievement yet recorded in the manœuvres for supremacy within the trade. This acquisition, including supertheatres in many of the more important cities in the country, the Fox-West Coast Theatres, and the Poli Circuit in New England, has given to the William Fox interests the most strategic position in motion pictures. Warner Brothers, who introduced Vitaphone (the-sound-on-disk method) to the industry, have acquired control of the Stanley Company of America, an important circuit in the East, and First National Pictures, Incorporated, together with other theatre acquisitions, and have thus placed themselves in a relatively strong position.

The recent consolidation of Keith-Orpheum Theatres and the producing units of Radio-Keith-Orpheum (formerly known as the Film Booking Offices) by the Radio Corporation of America, brings new business interests within the motion picture industry. This activity on the part of the Radio Corporation has led some people to believe that the American Telephone & Telegraph Company, because of its holdings in the Western Electric Sound System, has more than a passing interest in the motion picture industry. It seems very doubtful, however, that a public utility organization such as the American Telephone & Telegraph Company would invite complications by interesting itself in an industry so foreign to its own field.

The Paramount Famous Lasky Corporation has entrenched itself with the opening of new theatres at strategic points, thus insuring for itself adequate representation of product. It has quickly adapted itself to the new conditions brought about through the introduction of sound and will continue to be an influence of further progress within the industry.

Similar organizations, such as the Universal Pictures Corporation, the Pathé Exchange, Incorporated, the Hal Roach Studios, the Christie Film Company, the Mack Sennett Film Company, the Educational Film Exchange, the Columbia Pictures, Incorporated, and many others, are devoting their efforts toward the production of sound motion pictures and will continue to hold the same position within the industry that they held as producers of silent motion pictures.

The question has arisen, Is there the possibility of domination of the industry by manufacturers of electrical devices? In a creative industry such as ours men of talent and of experience will continue to hold the reins. No matter how perfect any mechanical device may be it is after all merely a tool which in the hands of the unskilled may be misused. The same brush and palette employed for the painting of a master, in the hands of the inexperienced would merely result in a daub of paint. The industry will continue to thrive only where human brains, energy, and experience are brought to the task.

The potentialities of sound have opened a greater field for the motion picture than ever before. The future of the screen is brighter from every artistic and economic point of view. The industry is just entering its greatest era of development and more than ever will justify the fact that it wields the world's greatest medium of expression. The future, with its greater plans, greater now than in any previous period of the business, brings to us the vision of the greater responsibility that is ours. The industry has a long, broad road to travel.

One meaningful clue to what direction that road will take is offered, as I pen these final words, in the statement of William Fox that he has quit the production of silent films for good and for all. Coming from him and voiced throughout the nation by the daily press, the pronounce-

ment has awakened public realization to the permanence of the movement. The news was received first in silence, then with comment of acceptance. A leader has pointed the way. The industry and the world will follow. Surely the period of indecisiveness is now concluded. With minds cleared of doubts we face to-morrows squarely, like workers who know the appointed task.

It is therefore not without some pardonable emotion that I round out my own offering for early publication. The explorations are finished. I fervently trust that this volume may serve the newcomers as chart and compass. They will need both to travel with us, or at least to start on the trail that has been blazed. Then, once pointed, let them follow as speedily as may be; and may the race, now as ever, be to the swift. What a change thirty years have brought! A generation ago, when the new territory was flung open, men swarmed over it like a migration of squatters and gipsies. But we have learned better; and now the van not only clears the way but leaves minute instructions behind. The industry has grown from an impulsive mob to an army of progress.

In this organization, this body of tradition, lies our firm security. We know what we are doing and where we are going. The pragmatism of maturity forms our judgments and points our real goals. The infant industry has attained full manhood, with eyes clear to records and facts—but best of all, with a new song of aspiration in its heart and on its lips. We shall chant it near and far; and to the sound men will turn and the whole world listen!

GLOSSARY

A GLOSSARY OF TECHNICAL AND SEMITECHNICAL WORDS

EVERY human activity seems to gather to itself a set of words and symbols that have special meanings when used in the particular field. The definitions that follow are intended to clarify the group of technical and semitechnical terms which are used in connection with sound equipment. The definitions in some cases are not scientifically complete, but they contain about all that can be given without impairing the clearness of an elementary and simplified list:

ALTERNATING CURRENT (Abbr. A. C.): An electric current that reverses in direction at regular intervals of time.

ALTERNATOR: A generator of alternating electromotive forces which produce alternating current when applied to a circuit.

AMMETER: An instrument for measuring electric current strength in amperes.

AMPERAGE: The rate of flow of electric current in a circuit measured in amperes.

AMPERE: The practical unit of electric current strength; the current produced by a potential of one volt in a circuit having one ohm resistance.

AMPLIFIER: An instrument that copies and magnifies the effect of a local source of energy in accordance with applied variations, to produce a greater effect than could be had from the applied variations alone.

ANODE: (1) An electrode leading current into a device.
(2) An electrode from which current passes within a device.

(3) An electrode toward which electrons flow within a device.

(4) A positively charged electrode.

ARC: An electric discharge of high intensity depending for its continued passage upon the heat it produces at one or both electrodes. In lighting, an arc is the result of maintaining an electromotive force between carbons which are somewhat separated, but between which current flows across an arc stream composed of the gases generated in the process of volatilization of carbon.

ARMATURE: (1) An iron member located in the field of a magnet. (2) The rotating part of a stationary-field motor or generator.

AUDIBILITY: The loudness of sound as reproduced in a telephone receiver; usually stated as some number of times louder than a signal that can barely be heard or distinguished.

AUDIO-FREQUENCY: A frequency of vibration that is within the normal audible range; usually taken as between 16 and 16,000 cycles per second.

AUDION: A vacuum tube containing a heated filamentary cathode, a cold anode, and a screen or grid control electrode interposed between them.

AUTO-TRANSFORMER: A transformer in which the same winding acts as part of both primary and secondary coils.

B BATTERY: A battery for the plate of the anode circuit of a vacuum tube; usually made up in blocks of several dry or wet cells connected in series producing electromotive force.

BUZZER: An electromagnetic circuit interrupter having a vibrating armature.

BY-PASS CONDENSER: A condenser of sufficient capacitance to offer low impedance to audio-frequency current, but much higher impedance to audio-frequency current than does the instrument across which it is connected. It may similarly be used to discriminate between audio-frequencies or lower frequencies and direct current.

CAPACITANCE: The property exhibited by an electric condenser which permits storage of an electric charge; often called capacity.

CHOKE: A coil of relatively low resistance to direct current but of high impedance to alternating current. It is used to store electrical energy for very brief periods of time, to cause a surge or piling up of voltage in a circuit, to bring a circuit into tune or resonance, or to provide a path for low-frequency or direct currents, but not for high-frequency currents.

CIRCUIT: A path in which electric current will flow when potential is applied.

CONDENSER: Two or more sheets of metal separated by an insulator called the dielectric. A condenser is used to store electrical energy. For brief periods of time to bring circuits into tune or resonance, to level out surges and inequalities in a current.

CONTROL: The electrode of a vacuum tube to which controlling variations are applied; the grid or screen electrode of an audion.

DAMPED WAVES: Waves whose intensity, at any given point in space, more or less gradually dies away.

DAMPING: The dying away of the intensity of a damped wave. If the intensity falls off rapidly the damping is said to be high or large.

DIELECTRIC: The insulating medium separating the plates of a condenser.

DIRECT CURRENT (Abbr. D. C.): An electric current flowing continuously in one direction. In a two-wire circuit, for example, direct current always flows from the positive source to the negative return; therefore, direct current always has a readily determinable polarity, while alternating current (A. C.), which is constantly reversing its polarity while flowing through a circuit, has no apparent polarity.

EARTH CONNECTION: The wire leading to water pipe, buried plates, or other conductors used as the ground terminal.

Electrolyte: A conductive liquid, such as the sulphuric acid solution in a storage cell. (Liquid in a storage battery.)

Electromotive force: The electric force that tends to produce a flow of electric current in a circuit; abbreviated e.m.f.; also called "potential difference," "electric pressure," "voltage."

Electron: The smallest electric charge, and negative in potential. A drift of electrons proceeds from negative to positive parts of a circuit and constitutes a flow of electric "current" that is conventionally taken as proceeding in the opposite direction (i. e., from positive to negative). The ultimate particle of negative electricity, which plays a fundamental part in the constitution of matter as well as in the electric current. Radioactive emanations, electric discharges, etc., consist of streams of electrons.

Electron tube: A vacuum tube depending for its operation upon electrons passing through it.

Fader: Used in connection with sound equipment, Western Electric. The fader is essentially a double "volume control," used to increase or decrease the volume heard from a reproducing equipment.

Filter: A system of condensers, choke coils, and resistors, or some of them, offering low impedance to certain frequencies but high impedance to others.

Frequency: The number of cycles of oscillation in each unit of time, usually given in terms of cycles per second; in alternating currents, the rapid reversal of the current through a circuit. Thus, we speak of a sixty-cycle current as one which has sixty complete reversals per second or a frequency of sixty cycles.

Frequency changer: A device that converts alternating current of one frequency into alternating current of another frequency; the usual conversion is a doubling or tripling of frequency.

Grid: The interposed screenlike control electrode of an audion.

Grid leak: A resistor connected across a condenser in the grid filament circuit of an audion. A very high, non-inductive resistance connected across the grid condenser or between the grid and the filament of a vacuum tube to permit excessive electrical charges to leak off to an external source, thus furnishing stable control under all operating conditions.

Ground (or earth, which is the term used in England): The term "ground" is used for any connection with the earth, a river, or the sea.

Hard tube: A vacuum tube from which practically all gas has been exhausted.

Henry: The practical unit of self-induction or inductance.

Hook-up: A diagram showing the wiring of any wireless receiving or transmitting set or any other electrical device.

Impedance: This is the term applied to the resistance offered by a coil of wire to a current flowing through it due to the combined action of its reactance and of the actual resistance of the conductor in ohms. This counteracts the flow of current to a greater or less degree. Impedance may be said to be the result of reaction, or the quality that tends to hold back the flow of current produced by an alternating electromotive force.

Inductance: Inductance, like capacity, plays a very prominent part in all alternating current circuits. It is that quality in a circuit which causes a current flowing through the circuit to create a magnetic field interlinked with it. The unit of inductance is the Henry. Inductance is the magnetic energy-storing property exhibited by coils of wire, and is greatly increased if the coil has a cone of magnetic material such as iron.

Inductor: Any part of an electrical apparatus which acts inductively on another part.

Input circuit: The circuit through which power is let into a device.

Insulator: A non-conductive material through which electricity passes only in negligible quantities.

Jack: A spring-contact receptacle into which a plug may be inserted for completion of one or more circuits.

Key: A switch designed for easy and rapid manipulation.

Kilocycle: One thousand cycles. Radio frequencies are conveniently expressed in kilocycles per second (abbreviated kc). A frequency of 500,000 cycles per second may be written 500 kc.

Kilowatt (Abbr. K. W.): One thousand watts, a unit used in measuring large amounts of electricity.

Loudspeaker: A telephone receiver designed for relatively large powers and capable of producing sounds of sufficient volume to be heard through a room; usually fitted with a horn.

Megohm: A unit of electrical resistance equal to one million ohms.

Microampere: A unit of electric current equal to one one millionth of an ampere.

Microfarad: A unit of electrical capacitance equal to one millionth of a farad.

Microphone: (1) A loose electrical contact of variable resistance.
(2) A telephone transmitter containing such loose contacts.
(3) A device for converting sounds into electrical equivalents in a given circuit. In other words the microphone transfers sounds to a given electrical circuit by causing certain variations in the flow of electricity. It is the instrument used in both wire and radio telephony to transmit speech, and generally consists of a mass of loosely packed carbon blocks and subjected to varying pressure by the vibration of the diaphragm.
(4) In a loose sense, the name is also applied to the transmitter used for picking up sounds in making sound pictures, although this instrument does not depend on microphonic contact action.

Milliampere (Abbr. M. A.): The thousandth part of one ampere.

Modulation: The process of impressing an audio-frequency variation, such as that of speech, upon a radio-frequency carrier; the control of carrier energy is in accordance with signal variations.

Ohm: The unit of electrical resistance and impedance.

Ohm's law: The fundamental law of electricity. It states that the current in amperes flowing through a circuit is equal to the pressure in volts divided by resistance in ohms.

Oscillations: Alternating currents of very high frequencies are called electrical oscillations. If the amplitude of a series of oscillations is constant the oscillations give rise to continuous or undamped waves; but if the amplitude is not consistent and is of a decaying nature (as in the spark method of transmission) we obtain damped waves.

Output circuit: The circuit into which a device delivers energy; in an audion, the plate-filament circuit.

Parallel: The side-by-side connection of several electrical devices, especially of battery cells having all the negative cell terminals connected together and all the positive cell terminals likewise connected.

Plate: The anode or output electrode of an audion (vacuum tube).

Plug: A connecting device for use in conjunction with a jack for convenient and rapid alteration of circuits or transfer of instruments.

Potential: The energy of an electrical charge measured by its power to work or with reference to some standard.

Potentiometer: A potential divided; a resistor arranged for convenient alteration of the electromotive force applied to a circuit.

Primary: The input coil or circuit of a transformer.

Radio frequencies: Frequencies corresponding to vibrations not normally audible to the human ear. All frequencies above 10,000 cycles per second are termed radio frequencies.

Reactance: The portion of impedance due to both inductance

and capacitance. Total reactance equals inductive reactance minus capacitive reactance.

REACTOR: An inductor of large value, usually having an iron core.

RECTIFIER: An apparatus which converts alternating current (A. C.) into pulses of direct current (D. C.). Tungar, Rectigon, and Kenetron apparatus are employed for rectifying purposes.

RELAY: A device by means of which electric power in one circuit controls electric power in another circuit.

RESISTANCE: Opposition to the flow of an electric current through a conducting medium. All metals have more or less electrical resistance. Copper is used universally for both electrical and radio work on account of its low resistance, comparatively low cost, and ready supply. Silver is a better conductor, but it is too expensive. The unit of resistance is the ohm.

RESISTOR: A unit or element in which resistance is prominent.

RESONANCE: A very important function of radio circuits. Resonance in a given circuit is said to exist when its natural frequency has the same value as the frequency of the alternating electromotive force introduced in it. The current is then in tune with the natural period of vibration of the circuit. The theory of electrical resonance is the same as that of acoustics, readily demonstrated by the tuning forks, where one tuning fork will not respond to another unless it is of the same key or pitch. Bringing a circuit into resonance means bringing it into tune with another circuit or transmitter.

RHEOSTAT: A variable resistance usually employed to control or regulate current flow.

SECONDARY: The output circuit or coil of a transformer.

SERIES: The tandem, or successive connection of several electrical devices in one circuit, especially of battery cells having the positive of one cell connected to the negative of the next, throughout the battery.

SHIELD: A plate or casing, usually connected to ground for preventing changes in capacitance.

Soft tube: A vacuum tube containing a slight residuum of gas, not so thoroughly exhausted as a hard tube.

Spark gap: A discharger across which the current flow disrupts air or other gas filling the "gap."

Static: Disturbances of an electrical nature which are created by natural causes and which interfere materially with radio work. When static is exceptionally bad it may be impossible to receive sound without noises, which sound like heavy crashes or a "frying" noise.

Stopping condenser: A by-pass condenser used to block the passage of direct current in a circuit.

Storage battery: Battery which can be recharged at intervals whenever it is run down; a storage battery is employed to supply current for operating vacuum tube filaments, field current for receivers, and also B-battery plate voltage.

Transformer: Any device used in electrical and radio work for the transference of energy from one circuit to another with or without a change in the voltage as desired. Thus we have power transformers, amplifying transformers, telephone transformers, oscillation transformers, tuning transformers, etc. All transformers have a primary winding, receiving the initial current, which is passed on to the secondary winding with the same voltage, a higher voltage, or a lower voltage, according to the ratio which the primary and secondary windings bear to one another. A transformer is an alternating current device for changing the ratio of voltage to current in two interlinked circuits, a primary and a secondary.

Turntable: A rotating device used with Western Electric Sound Equipment, on which are mounted wax disks which produce sound in connection with reproducers.

Undamped: A train of high-frequency oscillations of constant amplitude, such as continuous waves.

Vacuum tube: In radio work this term is applied to a glass tube exhausted of air and containing essentially a filament for the

creation of electrons; a plate, positively charged, to which the electrons are attracted; and a grid, consisting of a helix of fine wire, inserted between the filament and the plate for controlling the amount of the electronic flow. This action of vacuum tube plays three leading functions in radio work; namely, detection, amplification, and generation of high-frequency electro-magnetic waves.

VOLT: The practical unit of electromotive force; an electric pressure capable of producing a current of one ampere through a resistance of one ohm.

VOLTMETER: An instrument for measuring the voltage of a current flowing through an electric circuit.

WATT (Abbr. W.): The unit of electric power. To find power in watts multiply voltage by amperage. 746 watts equal one horsepower. 1000 watts equal one kilowatt (K. W.).

The foregoing list by no means covers all the terms which will be encountered in sound equipment, but it does cover the more common and perhaps least understood terms confronting the layman. It thus provides a core of information suitable for most circumstances.

I suggest that these terms should be understood by every person responsible for adequate operation, from the manager down. One should not be frightened away from technicalities by the mere sound. Often they mean something quite simple. Otherwise, in spite of theoretical difficulties, they have an immediate practical connection that can be learned in spite of the riddle of what lies behind. In almost every case a man can get to know the meaning of a term if he will try two or three times instead of giving up at once.

It is obvious that, when one is dealing with outside, expert assistance, one can coöperate most intelligently when one knows what the other man is talking about. Furthermore, the more detailed the knowledge inside the theatre, the less the dependence on help from elsewhere. I do not

mean that service facilities should not be called in. I mean that there are emergencies when it is difficult to get aid or impossible to get it at once. Thus a comparatively minor difficulty might hold up or close a performance, with disastrous effects on patronage. To cut this margin of disaster is the management's function; and the instrument thereof is ever fuller and wider knowledge of the machine and its lore.

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